APPENDIX A
SAMPLING AND ANALYSIS PLAN

FINAL

2008 Sampling and Analysis Plan

2008 Spring Sampling Event

Remedial Investigation

Upper Blackfoot Mining Complex

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1.0 INTRODUCTION

This 2008 Spring Sampling and Analysis Plan (SAP) has been developed by Tetra Tech on behalf of the Montana Department of Environmental Quality (DEQ) to provide guidance for field sampling activities at the Upper Blackfoot Mining Complex (UBMC) Facility located approximately 15 miles east of Lincoln, Lewis and Clark County, Montana (**Figure A-1**). This plan is a part of the larger Remedial Investigation (RI) that will be conducted over the next year at the Facility, including the draft RI Report due to DEQ on July 31, 2008. This plan will also be incorporated into an RI Work Plan that will cover proposed investigation activities for 2008 and was developed following review of the 2007 field investigation and identification of additional data gaps.

The 2007 expeditious fall sampling event was conducted so that critical data could be collected before the onset of winter, with the possibility that no other data could be collected until 2008 due to weather or access constraints. This SAP was developed based on historical data gaps and data gaps identified from the 2007 investigation. The 2008 Spring SAP consists of two parts, a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP). The project Health and Safety Plan (HASP) is included as **Appendix A-1** in this SAP. **Appendix A-2** includes Tetra Tech's Standard Operating Procedures (SOPs) and **Appendix A-3** include field forms.

2.0 BACKGROUND

The UBMC Facility is located about 15 miles east of Lincoln, Montana, in Lewis and Clark County. The complex consists of numerous mines located in the historic Heddleston Mining District including the Mike Horse, Anaconda, Capitol, Carbonate, Consolation, Edith, and Paymaster. Mining activity began with the discovery of silver, lead, and zinc-bearing ores in the late 1800s. Primary ore production occurred in the 1930s and 1940s at the Mike Horse Mine. In 1941, the Mike Horse Mining and Milling Company constructed a tailings impoundment on Beartrap Creek. The American Smelting and Refining Company (ASARCO) purchased the Mike Horse Mine and associated properties from the Mike Horse Mine and Milling Company in 1945 and continued mining operations through 1955. On June 19, 1975, this dam breached, releasing an estimated 200,000 cubic yards (yd^3) of tailings and fill/colluvial material into the Beartrap Creek and Upper Blackfoot River drainages.

DEQ prepared a Comprehensive Data Summary Report (DSR) for the UBMC in December 2007 (DEQ 2007a). This report 1) presents a compilation of all existing and available information relevant to the UBMC; 2) evaluated the data by comparing it to appropriate screening levels; and 3) identified additional data gaps. In general, the primary data gaps identified in the report that applied to the fall 2007 expeditious sampling event included the following:

- Soil data, including background samples, to determine the nature and extent of the contamination and assist in the preparation of ecological and human health risk assessments.
- Macroinvertebrate data to determine aquatic health.
- Sediment data to characterize current conditions within the river channel bottom and assist in the preparation of ecological and human health risk assessments.
- Surface water data to determine the nature and extent of surface water contamination downstream of BRSW-16 and assist in the preparation of ecological and human health risk assessments.
- Surface water data to determine the nature and extent of surface water contamination within the localized tributaries (including, but not limited to Paymaster Creek and Stevens Creek) and assist in the preparation of ecological and human health risk assessments.
- Alluvial and bedrock groundwater data, including the installation of additional monitoring wells, to determine the nature and extent of groundwater contamination and assist in the preparation of ecological and human health risk assessments.
- Mine site inventories of pits, prospects, and mines located in Stevens Creek and other areas of the complex.

These data gaps were considered to be critical data and were collected during the fall 2007 field event, while data gaps identified in the Remedial Investigation Work Plan (RIWP; DEQ 2007b) will be addressed during the spring 2008 field season. This SAP has been developed to address these data gaps.

Vegetation data will be collected in the spring 2008 event because it was too late in the season to collect good vegetation data. If the data from the fall 2007 field event indicates there are potential effects, mammal sampling will also occur during the 2008 investigation. Additional field work may be performed for soil, sediment, mine waste, surface water, and groundwater in 2008 if data collected during 2007 indicates additional data is needed to support the remedial investigation (RI). Additional data gaps may be identified during a formal review of the historic files for the Facility during winter 2007/2008. Tetra Tech will prepare an addendum to this SAP if follow-up investigation work is needed based on the information obtained from the 2007 investigation and historic review.

The following provides a list of data gaps that have already been identified for the 2008 investigation.

Mine Waste

- *Waste Deposit Volumes:* The approximate volume and area of each individual waste deposit must be determined. These data exist for some sites in the UBMC and volumes for dispersed tailings can be generated from data collected during the 2007 sampling event. If data for removed waste areas indicate the potential need to excavate contaminated soil it may be necessary to determine the depth of impacts in order to calculate the total volume of impacted soil. Field personnel will collect additional information during 2008 to fill this data gap while collecting soil samples, and while performing mine inventory activities.
- *Mine waste and water sampling:* The information obtained for the sites identified and investigated during the 2007 mine inventory program indicated that there are several previously undocumented or sampled mine waste piles, seeps or other water sources, and mine waste deposits that require further investigation. For these areas, Tetra Tech proposes mine waste sampling, sampling of seeps and other sources of water observed, and surface water sampling to evaluate potential impacts from mine waste.
- *Anaconda Mine Area Waste Piles:* During the 2007 investigation, field personnel also identified three mine waste piles that are present above the two mine waste areas that were formerly reclaimed on the slope above the Anaconda Mine. The perimeter and one composite sample was collected from one of these areas and one grab sample each from the other two were collected during the fall 2007 investigation. Additional sampling in 2008 for two of three of these areas will likely be required, pending results of the 2007 samples.

- *Mine inventory:* Inventory remaining mine waste areas in the UBMC, with coordination from DEQ.
- *Calliope Mine:* The Calliope Mine, located in Shave Gulch, should be inventoried in 2008 to evaluate potential impacts to Shave Gulch.
- The following list describes the previously recaimed areas that may require additional surface and subsurface soil sampling in 2008. The list includes areas not sampled in 2007 and 2007 sampled areas that are pending 2007 analytical results. This sampling may include evaluating revegetation success and analyzing soil for nutrient chemical data (i.e. nitrate, potassium, phosphate, and organic carbon).
  - Two Anaconda Mine waste removal areas beneath the wetland treatment system.
  - No. 3 Tunnel mine waste areas north of the Paymaster Road.
  - Paymaster Mine waste removal area that is currently beneath the former Paymaster constructed wetland.
  - Other reclaimed waste rock removal areas and areas of waste rock reclaimed in place that were sampled in 2007 may require additional sampling pending results of 2007 sample analysis.

Over Bank Deposits (Edge-of-Tailings)

Additional sampling is proposed to further define the lateral extent of tailing impacts from the 1975 tailings dam breach in preparation for remedial action planning. The number of samples and sample locations will be based on 2007 XRF and laboratory data. In addition, streams such as Paymaster and Stevens creeks may also require streamside sampling. This will be determined following review of historic data during winter 2007/2008 and based on 2007 investigation data.

Background Soil

The collection and analysis of additional background soil samples is a potential data gap. The need for additional samples and the number will be evaluated once XRF and laboratory analytical results for the existing samples have been reviewed and evaluated. Additional background soil samples may be needed if, for example, the 2007 data indicate that the background soil samples do not provide enough coverage for the geology types of the area and/or do not appear to characterize the area, as compared to historic and 2007 data. Collection of additional background soil samples, if needed, will be coordinated with DEQ.

Surface Water Data Gaps

- Surface water quality samples should be obtained upstream and downstream of the historic Calliope Mine in Shave Gulch to identify potential effects of that mine on Shave Gulch Creek, and
- Spring (high flow) surface water monitoring will be completed in 2008 to augment the existing surface water data set.

Groundwater

Review of historical groundwater data and additional data gathered during 2007 reveals a number of data gaps that are listed and described below. Additional information on these data gaps is presented in Section 3.7.

- Existing well ANMW-9 could not be located during the fall 2007 sampling event. That well should be either located or replaced so that groundwater quality in the alluvium along Anaconda Creek (a background area) can be monitored.
- Install multiple paired alluvium with bedrock wells in Shave gulch.
- Install one set of paired wells near the mouth of Pass Creek.
- Install monitoring wells in Shave Gulch near Capitol Mine.
- A paired well completed in bedrock should be constructed adjacent to well BCGW-115 in the Beartrap Creek valley.
- Install at least one monitoring well in the Mike Horse Mine workings.
- Install at least one monitoring well in the Anaconda Mine workings.
- Aquifer testing should be conducted using existing wells in the Blackfoot River alluvium in two representative areas – one near wells MPP-4 and BRGW-110 adjacent to the Mary P prospect and one near wells LCMW-1 and BRGW-101 near the downgradient end of the project area. An alluvial well and a bedrock well are present in each area.

The following section, the FSP, identifies sampling methods and analytical parameters for the above listed data gaps, as well as specific procedures for additional tasks identified during the data summary review process. Because additional historic review is planned for winter 2007/2008 and the 2007 data has yet to be reviewed and interpreted, this sampling plan may require the development of an addendum to this SAP which will submitted for review and finalized prior to implementing the 2008 field investigation.

3.0 FIELD SAMPLING PLAN

The primary information covered in this section is focused on eight environmental media: mine waste, surface water, sediment, groundwater, soil, aquatics, vegetation and mammals. Standard field methods covered include: measurement of field parameters (pH, conductivity, temperature, dissolved oxygen, oxidation-reduction potential); surface water sampling; surface water flow measurements; monitoring well installation; well development; groundwater sampling; aquifer testing; macroinvertebrate sampling; soil; mine waste sampling (hand augering and backhoe test pitting) vegetation cover and type; and mammal tissue sample collection. Detailed descriptions of sample designation, sampling methods, field note taking, completing field forms, sample packaging, and sample shipment are also described.

As stated in Section 2.0, this FSP, QAPP, and HASP were developed based on information obtained from the DSR (DEQ 2007a) and field observations made during the 2007 fall investigation. Additional historic review and evaluation and interpretation of the 2007 data is planned for winter 2007/2008. Following this review, this FSP, QAPP, and HASP may require modification. These modifications will be provided as an addendum to this SAP and submitted for review and finalized prior to commencement of the 2008 field investigation.

3.1 SAMPLE DESIGNATION AND LABELING

Sample designations will consist of a series of letters and numbers to indicate the sample site, sample type, media, and location. For established surface water, sediment, and groundwater stations, the established station number will be used. All samples will be labeled in the field along with the date and time of sample collection, the sample number, the sample depth if necessary, any preservatives used, and the sampler's initials. A permanent marker will be used for labeling.

3.1.1 Surface Water and Groundwater Stations

For new surface water and groundwater stations, a letter designation for the drainage where the station is located will be used. The drainage basin letter designates are: PM – Paymaster Creek; SG – Stevens Gulch; BR- Blackfoot River; BC – Beartrap Creek; MH – Mike Horse Creek; and PD - Pass Creek Drainage. For new sampling stations, if the sample is a surface water sample, the drainage basin code will be followed by the letters ‘SW’. If the sample is a groundwater sample, the drainage basin code will be followed by the letters ‘GW’. For new surface water and groundwater stations, a consecutive number beginning with the number 101 will be used. Examples of new and existing surface water and groundwater designation are shown below:

Surface Water	**Groundwater**
BRSW-101(new)	BCGW-101 (new)
BRSW-5 (existing)	BRGW-1 (existing)

3.1.2 Marsh and Streambed Sediment and Soil/Mine Waste Sample Designations

Mine waste and soil samples will be designated using a couple of different naming conventions. If additional soil samples are needed for the Upper Marsh, marsh sediment samples will be collected using the same grid as the 2007 investigation (a 500-foot grid and 250-foot subgrid network). Station names will be based on the grid-specific Northing and Easting location as follows:

- 0N0E-(0-2), where the 0-2 indicates the depth in inches from ground surface of the sample collected at the coordinate 0N0E.

Soil samples collected from test pits will be designated by the drainage code (see Section 3.1.1 above), followed by the letters 'TP', for test pit, the test pit number, and the sampling interval in inches. An example of this designation scheme is BRTP-1(12-24). Waste rock samples will be designated by the drainage code followed by the letters 'WR', a consecutive number beginning with 01, and the depth interval sampled. An example of this scheme is MHWR-01(0-2) as designated for the first sample collected in the Mike Horse Creek drainage from the soil depth interval 0- to 2-inches below ground surface (bgs). Background soil samples will be designated with the letters 'BG' a consecutive number beginning with 01, and the depth interval sampled. If mine waste is associated with a particular mine, the designation will reflect the name of the mine (i.e. MP for Mary P. mine waste).

For streambed sediment samples, the identifier will consist of the surface water station identifier followed by the letters 'SE' for sediment. Sediment sample depth will be indicated using the same system as soil samples.

3.1.3 Macroinvertebrate, Vegetation, and Mammal Sample Designations

Sample designations for macroinvertebrates will use the drainage name (i.e. for Blackfoot River) together with MI for macroinvertebrate followed by the sample location number. For example a macroinvertebrate sample collected at the existing surface water station of BRSW-23 would be designated BRMI-23.

Sample designations for vegetation and mammals will also use the two letter drainage designation followed by VE for vegetation and MA for mammals.

3.1.4 Quality Control Samples

All media will have field quality control samples submitted blind to the laboratory. Field quality control samples will include deionized water blanks, rinsate blanks, and blind field standards.

Field personnel will record QC sample identification in field forms and in field notebooks. The quality control sample will be differentiated from the natural sample by adding the following codes at the end of the sample designation number:

- Deionized Water Blank 'B'
- Rinsate Blank 'R'

Examples of quality control sample designations are provided below.

- BRGW-101B (new groundwater deionized water blank)
- BRSW-101R (new surface water rinsate blank)

Blind field standards will be submitted as a unique sample beginning with the letters 'BR' followed by the media designation (i.e. SW for surface water, GW for groundwater, SE for sediment, MW, for mine waste, etc.) and followed by consecutive numbers beginning with 400 . For example, a blind field standard for surface water would be BRSW-400, BRGW-400 for groundwater, and BRMW-400 for mine waste.

3.2 FIELD NOTES

All field observations will be recorded in project-dedicated field notebooks in accordance with SOP-12 (Sample Documentation). The standard project field books that will be used by all personnel will be the equivalent of the pocket-sized "Rite in the Rain"® All-weather Transit Notebook No. 301 (4-5/8 x 7" with numbered pages). Each field book will be labeled on the front cover with the project name, beginning entry date, final entry date, and general contents of notes (e.g. surface water sampling).

The field team leaders are responsible for recording information such as weather conditions, field crew members, visitors to the site, samples collected, the date and time of sample collection, procedures used, any field data collected, problems encountered in the field, and any deviations from this SAP. The field notebook will be the master log of all field activities. As such, in addition to standard field notations (e.g. field conditions, date, time, weather, field personnel, sample station number, etc.), information entered into the field notebook will also include: the number and type of measurements taken, the location and types of data recorded by another means (i.e. field forms, data recorder, or portable computer), the number of samples collected each day, sample packaging and shipping summaries (i.e. number and type of shipping containers, shipping carrier, date and time of shipment, etc.), and any other information relevant to the field event.

3.3 SURFACE WATER

The 2007 surface water sampling included additional sampling locations intended to fill identified gaps in the existing surface water data set. Details of the locations and purposes of the additional sampling points were presented in the 2007 fall investigation SAP (Tetra Tech, 2007). Inspection of other known historic mining features, such as the Calliope Mine in upper Shave Gulch, or discovery of other recently identified mining waste in the UBMC including some adits with discharges, and other currently unidentified historic mining features that are potential sources of contaminants to surface water could result in identification of additional data gaps in the surface water data set. However, at this time the surface water data set appears to be sufficiently complete with the exception of the following.

- Surface water quality samples should be obtained upstream and downstream of the historic Calliope Mine in Shave Gulch to identify potential effects of that mine on Shave Gulch Creek and other areas of potential mining impacts in Stevens and Paymaster Gulch; and
- Spring (high flow) water monitoring is proposed for 2008 to augment the existing surface water data set.

Additional locations may be selected for sampling in 2008 based on historic data gaps identified during the winter literature review and following review of the 2007 data. Surface water samples are proposed for stream reaches where historic data and 2007 investigation results indicate potential sources of loading may be impacting the stream, where few samples have been collected to characterize water quality, to fill data gaps, or to evaluate background surface water quality. **Figure A-2** shows historic and 2007 surface water sampling locations. **Table A-1** summarizes surface water sampling locations. Surface water sampling consists of measuring flow, measuring field parameters, and collecting samples. The following subsections describe each of these elements. **Table A-1** and **Figure A-2** may require modification, pending the final locations selected for the 2008 sampling event. The final locations will be based on the winter 2007/2008 historic data review and the 2007 investigation results. Any modifications will be presented in the addendum to this SAP.

Additional surface water sampling may be required at mine inventory sites (i.e. seeps or flowing adits). Surface water sampling at these locations will be performed according to the same methods as stream surface water sampling.

3.3.1 Flow measurements

Flow measurements will be taken in accordance with SOP-01 (Streamflow Measurement; Wading Technique) and will consist of one or more of the following methods: 1) Area-velocity method; 2) Portable flume method; or 3) Timed volumetric method (**Appendix A-2**). At high flow periods some downstream sites may be unsafe to wade. In such cases, flows will be estimated by measuring stream stage. A field form for calculating flow is included in **Appendix A-3**. Field personnel will estimate flow at stations where not enough water is present to gauge or the where gauging a specific cross section is difficult (i.e. water flow along the Blackfoot River within the marsh). In these cases, field personnel may estimate flow using the time-velocity method as defined in SOP-01.

3.3.2 Surface Water Field Parameters

Several types of field parameters will be measured. **Table A-2** lists the standard field parameters that will be collected in the 2008 spring sampling event. Field parameters will be measured according to the referenced Tetra Tech SOPs. Appropriate field forms will be filled out in accordance with SOP-10 (Field Forms). Field forms for recording surface water field parameters are included in **Appendix A-3**.

3.3.3 Surface Water Sampling

Surface water samples will be collected according to SOP-03 (Surface Water Quality Sampling). **Appendix A-2** provides Standard Operating Procedures (SOPs). Samples will be collected in clean laboratory-supplied bottles in accordance with those shown in **Table A-3**. **Table A-3** also lists preservation requirements for surface water constituents. For dissolved constituents (aluminum), samples will be filtered through a 0.45-micron disposable in-line filter using a peristaltic pump or bailer. Aluminum will only be filtered when pH of the surface water is within a pH range of 6.5 and 9.0 (see below). Non-disposable sampling equipment will be decontaminated between sampling stations according to SOP-11 (Equipment Decontamination). Sample collection will proceed in a downstream to upstream direction to avoid possible contamination of downstream samples due to upstream sampling activities.

3.3.4 Surface Water Analytical Methods

Constituents exceeding Montana water quality standards are identified in the DSR as the basis for the analytical parameters list. Montana water quality standards for metals (except aluminum) in surface water are based upon the analysis of samples following a “total recoverable” digestion procedure. As per Montana water quality standards, aluminum will be filtered and analyzed as dissolved, but only when the surface water sample is within a pH range of 6.5 to 9.0. **Table A-4** summarizes laboratory analytical parameters, holding times, EPA Analytical Method Number, required detection limits, and sample preservation.

3.4 STREAMBED SEDIMENT

Tetra Tech anticipates that additional sediment sampling will be performed during the spring 2008 investigation. **Figure A-3** shows the 2007 and historic sediment sampling locations. **Table A-1** lists some of the likely sediment sampling locations. The final number and location of the streambed sediment sampling locations will be determined following the winter 2007/2008 review of historic data and following evaluation and interpretation of the 2007 investigation results.

Each streambed sediment sampling location coincides with its respective surface water sampling station. Two separate streambed sediment samples will be collected at each station:

the first as a grab sample using a stainless steel spade according to Tetra Tech SOP-22, and the second as a grab sample that will be sieved at the laboratory through a 63-micron screen. Samples will be collected from the 0- to 2-inch interval at the surface of the streambed. However, if the streambed in the sample area is composed of fine-grained sediment and it is possible to dig deeper into the soft sediment using a trowel, gauge auger or other appropriate sediment sampler, field personnel will attempt to collect streambed sediment based on the following depth intervals: 0- to 2-inch, 2- to 6-inch, 6- to 12-inch, and 12- to 24-inch. Field personnel will note the type of streambed materials encountered and whether depth integrated samples were attempted.

Rock greater than 2 millimeters (mm) in size will be screened using a 10-mesh (2mm) sieve prior to placement in the sample jar. Samples will be placed in laboratory-provided sample containers and the water decanted so that the jar is filled with as much sediment as possible. Streambed sediment samples will be analyzed for total metals listed in **Table A-5**.

3.5 MARSH SEDIMENT SAMPLING METHODS

Tetra Tech anticipates that additional marsh sediment sampling may be performed during the spring 2008 investigation to fill data gaps from the 2007 investigation. The method will be consistent with the 2007 investigation and use the same methods as the 2007 investigation. The method is summarized below. The 2007 grid may require expansion or refinement in order to fill the data gaps. **Table A-6** presents the analytical methods for the 2008 data. The exact number of samples will be determined following evaluation and interpretation of the 2007 investigation data.

Tetra Tech will complete additional sediment sampling in the Upper Marsh (**Figure A-4**), as needed, to evaluate potential deposition in the marsh from the 1975 tailings impoundment breech, evaluate human health and ecological risk associated with possible tailings deposition in the marsh, and evaluate potential impacts to water quality in the Blackfoot River. **Figure A-4** shows the 2007 and historic marsh sediment sampling locations.

Tetra Tech developed a grid overlay for sediment sampling in the Upper Marsh (**Figure A-4**). The grid overlay is a 500-foot by 500-foot grid and a 250-foot by 250–foot subset grid. Sediment samples will be collected at specific grid nodes by completing hand dug test pits using a shovel or hand auger following SOP-22. The number and specific locations will be determined following the winter 2007/2008 historic data review and evaluation and interpretation of the 2007 investigation data. The locations will be surveyed and marked by licensed surveyors prior to conducting the sampling effort.

Hand dug test pits will be dug to a depth of about 12 inches and samples will be collected beginning from the top of the mineralized sediment interface (i.e. beginning at the base of the current vegetative root layer) to 2 inches (0-2 inches), 2-6 inches, 6-12 inches. The 0- to 2-inch depth interval will be used to evaluate potential risk to human health. The remaining depth intervals will also be used to evaluate risk to human health but also potential risk to ecological receptors, evaluate stratigraphic differences with respect to metals deposition, and evaluate areas of potentially elevated metals concentrations in preparation of remedial efforts.

During sampling, field observations will be noted in accordance with Section 3.2 of this plan. In addition to standard field observations at each sample location, field observations will be noted for general mine waste mineralogy, color, grain size, and the presence of any unique features. A photograph of the location of each hand-excavated test pit location will be taken with visual reference to surrounding topography if possible.

Sediment samples will be analyzed for the parameters listed in **Table A-6**. In addition, one-half of all marsh sediment will be submitted to the laboratory for acid base accounting (ABA) and Synthetic Precipitation Leaching Procedure (SPLP) analysis to evaluate potential leaching ability of metals from the soil.

3.6 MACROINVERTEBRATE SAMPLING

Tetra Tech anticipates that additional macroinvertebrate sampling will be performed during the spring 2008 investigation. The number and location of the samples will be determined based on the winter 2007/2008 historic data review and following evaluation and interpretation of the 2007 investigation data. **Table A-1** includes potential 2008 sampling locations. Any required modifications to the table will be presented in an addendum to this SAP prior to commencement of field activities.

Macroinvertebrate sampling will be conducted for both community indicators and for tissue sampling for metals analysis.

3.6.1 Macroinvertebrate Community Sampling

Methodologies to be employed are based on: United States Environmental Protection Agency (USEPA) Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters described (Klemm et al. 1990); USEPA Rapid Bioassessment Protocol for Use in Streams (Barbour et al. 1999); and MDEQ Water Quality Planning Bureau's SOP, Sample Collection, Sorting, and Taxonomic Identification of Benthic Macroinvertebrates (MDEQ 2006).

Macroinvertebrate samples will be collected from identified locations that coincide with a surface water sampling station (**Table A-1** and **Figure A-5**). Macroinvertebrate sampling will consist of collecting benthic macroinvertebrates and periphyton. Collection methods consist of collecting three quantitative Hess samples at each location. The Hess sample encloses 0.1 square meters (m') with a mesh size of 500 pm. Collections of the Hess sampler generates estimates of benthic macroinvertebrate densities in a given location and allows for statistical comparisons with future sampling efforts.

Macroinvertebrate samples will be preserved in the field with 95% ethanol and sent to EcoAnalysts, Inc. of Moscow, Idaho. Laboratory processing includes identification to the lowest possible taxonomic level and enumeration by taxon. A list of species will be created along with data on relative abundance, number of taxa, dominant taxa, and percent dominant taxa. Analysis will be performed to calculate biotic integrity indices, ratios of functional groups (scrapei, shiedder and filtering taxa), ratios of EPT (Ephemeroptera, Plecoptera, Trichoptera) and Chironomidae taxa, tolerance quotients, tolerance values, and community similarity indices. Macroinvertebrate samples will be collected according to SOP-47.

3.6.2 Macroinvertebrate Tissue Sampling

Methodologies employed to collect sufficient macroinvertebrate biomass for tissue analysis are based on: USEPA *Rapid Bioassessment Protocol for Use in Streams* (Barbour et al. 1999) and Montana DEQ Water Quality Planning Bureau's SOP, *Sample Collection, Sorting, and Taxonomic Identification of Benthic Macroinvertebrates* (MDEQ 2006). The same sites sampled for community analysis will be used to sample for tissue analysis.

Macroinvertebrate samples will be analyzed for the parameters shown in **Table A-7**.

Dip netting is the preferred method for collection due to the ease of use and the greater degree of portability when compared to Surber or Hess samplers. A Modified Surber or Hess Sampler may be used as designed if field conditions allow. Samples will be collected according to SOP-46. Samples will be stored in a freezer upon return from the field and kept there until shipped.

3.7 GROUNDWATER

Review of historical groundwater data and additional data gathered during 2007 reveals a number of data gaps that are listed and described below.

- Existing well ANMW-9 could not be located during the fall 2007 sampling event. That well should be either located or replaced so that groundwater quality in the alluvium along Anaconda Creek (a background area) can be monitored.
- Paired wells, with one of the pair completed in alluvium and the other completed in bedrock beneath the alluvium, should be constructed in Shave Gulch. Recommended locations are near the mouth of Shave Gulch downgradient of the Consolation Mine, in Shave Gulch upstream of the Consolation Mine, and upstream and downstream of the Calliope Mine in the western tributary of upper Shave Gulch. These wells would allow assessment of groundwater flow and quality near the mentioned mines and just above the point where groundwater discharges from the Shave Gulch alluvium into the Blackfoot River alluvium.

- One set of paired wells should be constructed near the mouth of Pass Creek to allow assessment of groundwater flow and quality near just above the point where groundwater discharges from the Pass Creek alluvium into the Blackfoot River alluvium.
- Monitoring wells should be constructed in upper Stevens Gulch near the Capital Mine to help assess the effectiveness of reclamation in that area.
- Alluvial well BCGW-115 in the Beartrap Creek valley was to have been completed in bedrock to allow evaluation of the bedrock groundwater quality. A paired well completed in bedrock should be constructed adjacent to well BCGW-115. The depth of this well will be determined through a survey of well measuring point elevations.
- At least one monitoring well should be installed in the Mike Horse Mine workings. The well(s) would provide information on the water level in the workings and assessment of how effective the existing mine adit plugging has been at flooding the workings and preventing the exposure of the workings to the oxidizing environment above the water level. The well(s) would also allow future comparative monitoring of hydrogeologic conditions in the mine in the event that the flow-through bulkhead is converted to a water-tight plug and the adit is actually sealed to prevent through-flow.
- A similar well should be constructed in the Anaconda Mine workings.

Aquifer testing is proposed for existing wells in the Blackfoot River alluvium in two representative areas – one near wells MPP-4 and BRGW-110 adjacent to the Mary P prospect and one near wells LCMW-1 and BRGW-101 near the downgradient end of the project area. An alluvial well and a bedrock well are present in each area. The testing would include pumping of the alluvial well and monitoring of both the alluvial well and bedrock well during and following the pumping. Groundwater samples for water quality testing should also be collected during the early and late parts of the test. The testing would provide data on the hydraulic conductivity of the alluvial aquifer, which could be used in evaluation of the mass transport of contaminants through the alluvial aquifer. The testing should also provide at least limited data on the interconnection of the alluvial and bedrock groundwater systems in those areas.

Tetra Tech anticipates that additional monitoring wells will be installed and groundwater sampling will be performed during the spring 2008 investigation. The exact number and location of wells to install and/or sample will be determined based on the winter 2007/2008 historic data review and evaluation and interpretation of the 2007 investigation data. **Table A-8** presents the likely groundwater sampling locations. Any modifications required to **Table A-8** based on the historic review and 2007 data will be provided in the addendum to the SAP prior to commencement of the 2008 investigation.

This task involves installing new monitoring wells and developing and sampling those wells, in addition to sampling select existing wells. **Figure A-6** shows the historic and 2007 location of groundwater monitoring wells, and **Table A-8** lists the justification for each well.

Groundwater sampling will involve measuring field parameters and collecting water samples. The following subsections describe these elements.

3.7.1 Monitoring Well Installation

The number of wells to be installed will be determined based on the results of the winter 2007/2008 historic data review and 2007 investigation results. Standard monitoring wells will be installed according to Tetra Tech SOP-16 and State of Montana requirements, including the requirement that drillers will file well logs with the Montana Department of Natural Resources and Conservation (DNRC). A drilling firm subcontracted to Tetra Tech will drill either 6-inch or 8-inch diameter boreholes using air rotary methods. The driller will collect cuttings samples every 10 feet or at changes in lithology. The Tetra Tech scientist supervising the drilling work will log cuttings samples to identify lithology and groundwater intervals encountered. Drill cuttings will be disposed of in accordance with DEQ's Purge Water Disposal Flowchart (criteria applied to soil instead of water). In general, since drill cuttings will not be considered a RCRA hazardous waste as defined by USEPA, drill cuttings will be land applied in the vicinity of the well in a manner that does not cause surface water discharge. Due to limited site access and mountainous terrain, select well locations may be restricted to areas with mine waste or tailings present. If mine waste or tailings are encountered, drill cuttings will be stored in a pile adjacent to the well to await final disposal when the area is remediated.

In general, monitoring wells will be installed for the purpose of evaluating both shallow alluvial groundwater and deeper bedrock groundwater. New well sites will have co-located shallow and deep monitoring wells. Based on the total depths of the historic deep bedrock monitoring wells, the new bedrock wells are not anticipated to penetrate greater than 100 feet. Based on site conditions, select boring locations may penetrate greater than 100 feet but not more than 200 feet at the discretion of the Tetra Tech scientist supervising site work. Boreholes will penetrate bedrock a minimum of 40 feet prior to completion. Wells will be installed within each borehole in accordance with applicable state regulations for monitoring wells. Wells are anticipated to be constructed of 2-inch diameter schedule 40 PVC with 0.020-inch slot screened sections. The screened interval will be a minimum of 20 feet in length in attempt to intercept the greatest number of water yielding fractures. However, the screened interval will not "bridge" the bedrock-alluvium interface. Wells will be completed with: 1) 10-20 silica sand to two feet above top of slotted casing; 2) bentonite seal from top of sand pack to within 1 foot of grade; and 3) a 2-foot steel lockable stick-up well protector set in concrete.

Alluvial wells will be constructed of 2-inch diameter schedule 40 PVC with 0.020-inch slot screened sections. The screened interval will be a maximum of 10 feet in length. Wells will be completed with: 1) 10-20 silica sand to two feet above top of slotted casing; 2) bentonite seal from top of sand pack to within 1-foot of grade; and 3) a 2-foot steel lockable stick-up well protector set in concrete.

Monitoring wells will be developed according to Tetra Tech SOP-17. Development water will be disposed of according to DEQ's Purge Water Disposal Flowchart. Historically groundwater monitoring wells drilled in the UBMC have not encountered water with characteristics approaching those of a RCRA hazardous waste (with the exception of wells UMHMW-1S and UMHMW-2S, both of which are located in a highly impacted area at the Mike Horse Mine). Based on this information, encountering groundwater that would be characterized as a RCRA waste in unlikely. Therefore development water will be land applied in the vicinity of the well in a manner that does not cause surface water discharge. Each well will be surveyed by a licensed surveyor registered in the State of Montana as defined under Title 37, chapter 67, Montana Codes Annotated. The vertical elevation will be based on the National Geodetic Vertical Datum of 1929 as referenced from a nearby U.S. Geological Survey marker, U.S. Coast and Geodetic Survey marker, or other similar marker if available. The vertical survey of the monitoring wells themselves must be accurate to the Fourth Order Class A (0.10 feet x square root of total distance of level loop in miles) with a measurement precision of 0.01 feet.

3.7.2 Groundwater Field Parameters

Table A-9 lists standard field parameters that will be measured during all groundwater sampling events. Field parameters will be measured according to the referenced Tetra Tech SOPs. Appropriate field forms will be filled out in accordance with SOP-10 (Field Forms). A groundwater field parameter form is included in **Appendix A-3**.

3.7.3 Groundwater Sampling

The depth to water and total depth of each well will be gauged prior to purging and sampling the well using an electronic water level probe. Purge water will be disposed of according to DEQ's Purge Water Disposal Flowchart. Historically groundwater monitoring wells drilled in the UBMC have not encountered water with characteristics approaching those of a RCRA hazardous waste (with the exception of wells UMHMW-1S and UMHMW-2S, both of which are located in a highly impacted area at the Mike Horse Mine). Based on this information, encountering groundwater that would be characterized as a RCRA waste in unlikely. Therefore development water will be land applied in the vicinity of the well in a manner that does not cause surface water discharge. Purge water from monitoring wells UMHMW-1S and UMHMW-2S will be considered a RCRA waste due to the likely elevated concentrations of heavy metals. Purge water from these two locations (approximately five gallons total, per sample event) will be placed in the Mike Horse Pretreatment Pond which receives Mike Horse adit discharge water for treatment. A number of methods will be used to collect groundwater samples including hand bailing, hand pumping, and submersible pumping. The method used for groundwater sampling will depend on well depth, well completion details, and accessibility and may vary from well to well. However, the preferred method of sampling, when possible, will be to use a low-flow submersible pump. All groundwater samples will be collected according to SOP-18 (Groundwater Sampling). Samples for metals analysis will be filtered through a 0.45-micron disposable in-line filter and collected in clean laboratory-supplied bottles in accordance with those shown in **Table A-10**. **Table A-10** also lists preservation requirements for groundwater constituents. Non-disposable sampling equipment will be decontaminated between monitoring wells according to SOP-11 (Equipment Decontamination).

3.7.4 Groundwater Analytical methods

Table A-11 summarizes laboratory analytical parameters, holding times, EPA Analytical Method Number, required detection limits, and sample preservation.

3.8 MINE WASTE/SOIL SAMPLING

Tetra Tech anticipates that additional mine waste will be sampled during the spring 2008 investigation. The number and location of sampling locations will depend on the winter 2007/2008 historic data review and evaluation and interpretation of the 2007 investigation results. The purpose of this sampling will be to fill data gaps and collect additional characterization data for development of remedial actions.

As part of the mine waste/soil investigation, field personnel will also collect data to support calculation of waste volumes for possible removal and/or reclamation efforts.

3.8.1 Mine Waste & Mine Waste Removal Area Sampling

Tetra Tech sampled several mine waste areas during the 2007 investigation. Field personnel will perform additional sampling in mine waste areas during 2008. The number of samples and locations will be determined following the the winter 2007/2008 historic review and evaluation and interpretation of the 2007 investigation data, **Figure A-7** presents an overview of mine waste areas. Additional areas will likely include areas identified during the 2007 mine inventory effort. Areas identified as data gaps following the 2007 investigation include:

- Two Anaconda Mine waste removal areas beneath the wetland treatment system and solids/sludges within the Anaconda wetland treatment cells.
- Three waste areas/possible waste removal areas on the hillside above the two known Anaconda waste pile removal areas.
- The Paymaster Mine waste removal area beneath the former Paymaster constructed wetland.
- No. 3 Tunnel mine waste area north of the Paymaster Road.

Additional investigation areas may be indentified after review for mine inventory areas and will be determined following review and discussion with DEQ prior to commencement of the 2008 field effort. The sampling areas and any additional analytical requirements will be identified in an addendum to this SAP, as needed.

In areas where mine waste was removed, sampling will be performed to evaluate the effectiveness of the removal action by evaluating whether metals remain following the previous remedial effort. The field investigation will likely include: 1) soil/mine waste sampling along the perimeters of the removal areas; 2) soil/mine waste in the central portions of the mine waste area; 3) soil/mine waste sampling from areas that have had no known remedial action; and 4) sampling solids/sludges in the Anaconda wetland treatment cells. The purpose of this sampling is to evaluate whether concentrations remaining in these areas are present at concentrations that are a potential threat to human health and ecological receptors, and evaluate whether metals may be mobilized from the area and impact surface water or groundwater.

In mine waste remedial areas that were not sampled in 2007, field personnel will sample the perimeter of each mine waste/mine waste removal area by taking one sample for every 50 linear feet surrounding the removal area. The samples will be collected from near the edge, just beyond the estimated removal limits. The goal of this sampling is to focus primarily on the outside edges of the reclamation. The samples will be collected from each location from the 0- to 6-inch depth interval, beginning at the base of the current root layer, if present. One to two surface soil composite samples (0 to 6-inch) will also be taken from the central portions of areas, depending on the size of the area, where the mine waste was reclaimed in place. The composite samples will be comprised of 5 to 6 subsamples distributed over the area such that the samples provide a representative composite over the area.

Each soil/mine waste sample will be analyzed by x-ray fluorescence (XRF) and the metals in **Table A-12** recorded on field XRF log sheets. One per every 10 soil/mine waste samples (10 percent) will be submitted to the laboratory for analysis for the constituents listed in **Table A-12.** In addition, one-half of the samples submitted for laboratory analysis will also be analyzed for ABA and SPLP. The XRF screening levels that will be used for the project are the most stringent ecological soil screening levels. The screening levels are as follows:

Arsenic: 10 mg/kg	Cadmium:0.36 mg/kg	Copper:28 mg/kg
Lead:11 mg/kg	Manganese:500 mg/kg	Mercury:0.1mg/kg
Zinc:50mg/kg	Iron: (no screening level)	Aluminum: 50 mg/kg

3.8.2 Edge of Streamside Impacts Soil Sampling

Field personnel will perform additional streamside soil sampling as part of the investigation. Streamside soil sampling will potentially include select portions of Mike Horse Creek, Beartrap Creek, Blackfoot River, Paymaster Creek, and Stevens Creek. The purpose of streamside soil sampling is provide an initial screening of the extent of tailings deposition to evaluate the edge of impacted soil primarily for risk assessment purposes and to evaluate the extent for possible removal actions. The number and location of samples will be determined following review of 2007 investigation data and the results of the winter 2007/2008 historic data review. The locations will be presented in an addendum to this SAP prior to commencement of the field effort.

Sample Methods – Beartrap Creek, Blackfoot River, Mike Horse Creek

The 2007 investigation included sampling along Beartrap Creek, Blackfoot River, and Mike Horse Creek. Sampling included starting at the approximate beginning of each stream. Beartrap Creek started at the confluence with Beartrap Creek and Mike Horse Creek, Blackfoot River sampling started at the confluence of Anaconda Creek and Beartrap Creek, and Mike Horse Creek sampling started below the concrete dam at the headwaters of the creek. Sampling along these reaches including locating the approximate edge of tailings, laterally from the stream, via visual observations. Field personnel collected one sample at the approximate edge of tailings, one sample 25 feet closer to the stream and one sample 25 feet beyond the estimated edge of tailings location. In some instances, the distances were modified based on the distance from the marked edge of tailings and the stream location or due to topography (i.e. edge of hillside). Samples were collected from the 0- to 6-inch depth intervals, beginning at the base of the vegetative root layer.

Field personnel advanced downstream along each of these streams at 100-foot intervals until the Upper Marsh was reached on the Blackfoot River, the Blackfoot River was encountered for Beartrap Creek, and the floodplain for Mike Horse Creek ceased to exist such that sampling could be performed. This occurred adjacent to the Mike Horse Creek settling pond area.

Samples were labeled according to their stream designation (i.e. BR for Blackfoot River, BC for Beartrap Creek, etc.). The designation was followed by “EOT” to designate edge-of-tailings sampling which was followed by the distance downstream and the sample location, 0 for the estimated edge-of-tailing, -25 for 25 feet toward the stream and +25 for 25 feet beyond the estimated edge-of-tailings. For example, a sample collected from 25 feet beyond the edge-of-tailings marker on the south side of the river 2,300 feet downstream of the starting point on the Blackfoot River would have the designation: BREOT-S23+25 (0-6”).

Field personnel removed gravel ½-size inch and greater from the sample during collection in preparation for screening. The subsamples were placed in one-gallon resealable bags to provide enough volume for screening with a 10-mesh (2 mm) sieve prior to analysis with the XRF and containerizing for laboratory analysis. A minimum of approximately 40 ounces (approximately 3/4-bag) of soil may be required, depending on the analyses (metals plus ABA and SPLP).

The same sampling method described above will be implemented for the 2008 sampling for streams that were not sampled during the 2007 investigation.

Sample Analyses

The samples were homogenized within the bag then screened to minus 10-mesh screen size (2 mm). Field personnel then analyzed the soil sample and recorded the XRF results for the metals listed in **Table A-12** on field XRF log sheets. Field personnel submitted 10 percent (1 in every 10) samples to the laboratory for verification analysis. The samples were analyzed for the constituents in **Table A-12.** In addition, one-half of all of the samples submitted to the laboratory were analyzed for ABA and SPLP. Samples submitted to the laboratory for analysis were transferred to laboratory-provided sample jars. Field analysis and handling for the 2008 investigation will be consistent with the above method.

Field Documentation

Field personnel placed a stake at each edge-of-tailings sampling location. The stake was marked in indelible ink and survey flagging. Each sampling point was also surveyed using a Trimble GeoXT handheld global positioning satellite (GPS) receiver so that the locations can be located for future work. Field personnel allowed the GPS unit to receive eight to 10 location readings at the corner points before recording the location. The GPS unit was set to record latitude and longitude according to Montana State Plane. Field documentation for the 2008 investigation will be consistent with the above method.

3.8.3 Background Soil Sampling - General

Tetra Tech anticipates that additional background soil sampling may be needed for risk assessment purposes, pending the results of the 2007 investigation and discussion with DEQ. The number of samples and sample areas will be determined following review and evaluation of 2007 data. The number and location of the samples, if needed, will be included in an addendum to this SAP.

Field personnel will collect background soil samples by hand excavating with a shovel or hand auger. Field personnel will collect the soil samples from the 0- to 6-inch depth interval. Forest duff will be cleared from the sample location prior to excavation and sampling. If vegetation is present, the sampling intervals will begin at the base of the root mass.

Background soil samples will be field screened using the XRF and analyzed for the parameters in **Table A-12**. In addition, the three background soil samples with the highest metals concentrations, as measured with the XRF, will also be analyzed for ABA and SPLP to evaluate natural conditions related to acid generation and leaching of metals from the soil.

3.8.4 Soil Sample Containers & Preservation

All soil, sediment, and mine waste samples will be placed in laboratory-provided sample containers. The exception to this is the streamside soil samples that will be collected in one-gallon re-sealable bags. The streamside soil samples that are sent to the laboratory for verification analysis will be transferred to laboratory-provided sample jars and the remainder will be temporarily archived. All samples sent to the laboratory will be kept together in re-sealable bags, together in the same cooler, for shipment to the laboratory.

All samples will be chilled to 4°C using doubled-resealable bags filled with ice. There are no holding times or preservatives for mine waste samples except mercury (28 day holding time).

3.9 MINE SITE INVENTORIES

Tetra Tech completed inventories for nine mine sites in the UBMC in 2007; however, many other areas remain to be inventoried. These areas will be inventoried during the 2008 investigation. **Figure A-7** shows the location of the 2007 inventoried sites and sites where inventories will be completed during the spring 2008 field event. Field personnel will log in a field note book the location of the mine site and significant features (mine waste areas, structures, shafts, adits, etc.) using a hand held GPS unit. Field personnel will also estimate the approximate size and volume of mine wastes, note whether mine waste is in contact with or near stream channels, note the type of structures present at the site (site buildings, cribbing structures, mine waste flumes, remaining equipment debris, etc.). Photographs of each feature will be taken for future reference. Field personnel will also provide a site sketch of the area.

The following presents a list of potential sites to inventory during 2008. The sites to inventory will be selected based on discussions with DEQ and on a priority system, based on their proximity to the drainage bottom and potential to impact surface water and groundwater:

- Sterling Claim (Patented) – Tunnel No. 21, potential dump 200 feet north of 300 adit.
- Little Nell Claim (Patented) – Tunnel No. 20, potential dump 200 feet north of 100 adit.
- Mike Horse Claim (Patented):
- Tunnel No. 5, potential dump reclaimed in upper Mike Horse.
- Tunnel No. 4, potential dump reclaimed in upper Mike Horse.
- Tunnel No. 7, potential dump 200 feet west of 100 adit.
- Tunnel No. 2, potential dump 150 feet west and 200 feet north of Tunnel No. 7.
- Tunnel No. 3, potential dump
- Tunnel No. 19 – 350 feet from Mike Horse claim boundary/150 from Copper Wreath
- Tunnel No. 18 – 65 feet northwest from Tunnel No. 19
- Tunnel No. 17 – 125 feet northwest from Tunnel No. 18
- Tunnel No. 16 – 425 feet from Mike Horse claim/25 feet from Snowdrift

- Tunnel No. 15 – 35 feet northwest of Tunnel No. 16
- Tunnel No. 14 – 50 feet north of Tunnel No. 15
- Tunnel No. 13 – 100 feet north of Tunnel No. 14
- Capital No. 2 Claim (Patented) – Tunnel No. 22 located 300 feet from Capitol/325 feet from Denver.
- Carbonate No. 2 Claim (Patented) – Tunnel No. 2 "Carbonate Mine" reclaimed by ASARCO and ARCO in 1994/1995
- DB hole (diamond bit hole) – 200 feet upstream of Tunnel No. 1
- Tunnel Site Claim (Patented) – 2 tunnels at northwest edge of claim next to Eureka Claim
- Daylight Claim/Copper Gate Claim (both Patented) – No. 2 Tunnel, eastern edge of claims overly
- Midnight Claim (Patented) – No. 1 Tunnel 200 feet up from Sunlight/Midnight overlay
- Mary P Claim (Patented) – Tunnel and waste rock next to road, adit 400 feet off of road
- Iron Hill Claim (Unpatented) – possible tunnel 300 feet up and north of Blackfoot River
- Black Foot Belle Claim (Patented) – Tunnel 700 feet north of Blackfoot River
- Little Joe Claim (Patented):
- Tunnel 1,150 feet from Mary P waste pile
- Anaconda Claim (Patented) – Tunnel of Anaconda mine reclamation
- Blue Cristle Claim (Patented) – Tunnel part of Anaconda mine reclamation
- Big Dick Claim (Patented) – 5 tunnels on hillside
- Calliope Mine – Shave Gulch

3.10 VEGETATION SAMPLING

Vegetation sampling will likely include both mine waste areas, reclaimed areas, and areas not suspected of containing mine waste. The sampling and analytical methods will be determined based on the data gaps identified from the 2007 investigation and the winter 2007/2008 historic data review. If modifications are needed, they will be presented in an addendum to this SAP.

The vegetation sampling effort will consist of the collection of vegetation data to compliment historical and future data collection of other parameters (i.e. soil, water, etc.). Vegetation data, in conjunction with the other data, will provide the basis for developing a reclamation plan for the UBMC.

The goal is to evaluate the environmental risks from heavy metals assimilation and content of vegetation. Exposure points could exist throughout the UBMC.

The primary pathway that is being considered by the vegetation assessment is as follows:

- Soil→ vegetation→wildlife (terrestrial food chain pathway)

The SAP will include an initial comparison of the measured heavy metal content in vegetation samples against the content levels that are measured in vegetation samples taken from undisturbed/control soils in close proximity to the UBMC. Heavy metal concentrations will be calculated and compared to accepted, published reference values (i. e., No Observed Adverse Effects Level (NOAEL) and Low Observed Adverse Effects Level (LOAEL)) that are considered to be safe to potential human and ecological receptors. NOAEL concentrations of heavy metals are considered to be safe to individual organisms of a population while LOAEL concentrations are considered to be safe to populations of wildlife species. Reference values that will be used are based upon published dose-response studies.

3.10.1 Field Data Collection

In order for accurate determination of aboveground heavy metal content of vegetation, individual plant species must be clipped, catalogued and stored, and shipped to a laboratory for analysis. The following discussion describes the methods necessary to collect vegetation in a manner that will enable statistical quantification of heavy metal occurrence across UBMC as well as ensuring a high level of quality assurance and control.

Vegetation plots will be situated adjacent to, but outside of soil sampling plots. Vegetation and soil sampling plots will be randomly situated throughout the UBMC and adjacent areas considered to be undisturbed by historical mining activities. All sampling locations will be located by GPS coordinates. The spatial pairing of these two response variables (vegetation and soils) will enable the final analysis to correlate above- and below ground heavy metals content more accurately. Vegetation plots will consist of two x two m quadrats to ensure sufficient material can be collected (Steward et al 1994). Quadrats should be placed adjacent to the soil plot in an immediate location that is representative in cover and dominant species composition to the surrounding area.

Within each quadrat, aerial cover of vegetation will be estimated within a one x one m subplot at the upper right corner of the quadrat. Estimations of cover will be conducted prior to sample collection. Absolute cover will be recorded for total vegetation by species, biological soil crust, litter, rock, and bare soil. Evaluation of cover by species will enable Tetra Tech to estimate heavy metal content in vegetation across UBMC. Ultimately when compared with soil, water, and organism analyses, a rudimentary budget of heavy metal fate will be capable of being developed.

When present, samples will be collected from three different perennial vegetation strata: shrub, forb, and grass. With respect to this SAP, shrubs will be considered woody species exhibiting less than 1 inch basal diameter. Forbs will be considered non-woody dicotyledonous species. Grasses will be considered non-woody monocotyledonous species. Annual vegetation will not be sampled/collected for lab analysis.

Starting from the center of the plot, species will be clipped in sufficient amount to obtain a 5-10g sample. The two most abundant species per stratum will be collected in each quadrat for a maximum of six species sampled (Woodbury et al 2004, Steward et al 1994). Samples of individual species will be collected only from those species present at greater than 2 percent absolute cover within the two x two meter quadrat (Steward et al 1994). In the event that insufficient vegetative biomass exists for one of the two most abundant species in the quadrat, only the sample of sufficient biomass will be collected, and the lack of sample will be noted. If no sufficient vegetative cover, relative to sample collection, occurs at the plot location, aerial cover will be estimated and field personnel will note that no vegetation samples were collected. Vegetation will be clipped at its base and the entire individual (leaves, stems, flowers, and fruits) will be collected. Different species of vegetation store nutrients and metals at different locations throughout the individual. In order to determine an accurate measurement of heavy metal total content, all of the aboveground tissue of the individual species must be collected. The shears will be washed with Alconox® and triple rinsed with deionized water between uses in separate quadrats. Latex gloves will be worn by the collector during sampling. Each sample will be placed in an airtight plastic bag. A sample label will be completed and placed with the bagged sample into a second airtight bag, placed in a cooler with sufficient double-bagged ice, and kept at a maximum temperature of 4ºC until analysis. Samples will be transported to the laboratory within 60 hours of collection.

For every 10 plots that are sampled, one duplicate sample will be collected. The duplicate will be sampled from within the same quadrat as the primary sample. Field personnel will need to consider sample volume to ensure that an adequate volume of vegetation is collected for the primary sample and the duplicate sample. In the event that insufficient vegetative biomass occurs within the plot, the duplicate sample will be taken in the first subsequent plot that is sampled and exhibits sufficient vegetative biomass to accommodate a duplicate sample. However, field personnel must maintain a minimum 10 percent duplicate-to-primary sample ratio.

An example of an appropriate sample label is contained in **Appendix A-3**. Sample labels will be printed on waterproof paper and completed at the time of sampling. At a minimum, sample labels will include:

- Sample plot identification code/number;
- Names of field personnel collecting sample;
- Date and time of sample collection;

- Sample type (PRIMARY or DUPLICATE)
- Environmental medium being sampled (exclusively VEGETATION);
- Desired lab analysis (exclusively HEAVY METALS CONTENT)
- Genus and species of sample collected; and
- Vegetation stratum of sample collected (SHRUB, FORB, GRASS).

3.10.2 Lab Sample Analysis

After collection, samples will be labeled and stored as described in the previous discussion. The coolers will include the chain-of-custody form, taped shut and chain-of-custody seals will be attached to the outside of the cooler to ensure that the cooler cannot be opened without breaking the seal.

All samples will be shipped for laboratory receipt and analysis within the lab specified holding times. Prompt shipping and analysis should be done to minimize the possibility of exceeding holding times, but also is of extreme importance when dealing with biological tissue samples in order to minimize risk of organic decomposition and/or chemical leaching and element speciation.

Table A-13 outlines the expected parameters to be evaluated.

3.11 SMALL MAMMAL SAMPLING

Tetra Tech proposes to perform small mammal sampling in areas that indicate a potential threat to ecological receptors. The number and location of samples that will be collected will depend on evaluation and interpretation of the 2007 investigation data and winter 2007/2008 review of historic data. Analytical requirements will also depend on the type of sampling that is performed. Tetra Tech will provide the number and location of samples and sample analyses in an addendum to this SAP prior to commencement of the 2008 field effort.

3.11.1 Field Sampling Plan

Small mammal sampling and tissue collection will be conducted for the determination of concentrations of Chemicals of Potential Ecological Concern (COPECs) in liver tissues of small mammals that inhabit the study area.

3.11.2 Sampling Procedures

Small mammals will be trapped using small Sherman live-traps baited with oats and peanut butter. Cotton balls will be placed in each trap to aid in temperature regulation of the captured animals. Traps will be placed every 10 m along transects within the sampling area at a number sufficient to obtain an adequate sample volume. Traps will be set in the evening and checked each morning for one to four nights, until an adequate sample is collected.

Captured animals will be identified to species, age, and sex. Those not chosen for collection will be immediately released. Twenty individuals will be selected for collection, with preference for non-breeding (non-scrotal males, non-lactating and non-pregnant females) adult deer mice (*Peromyscus maniculatus*), dependant on capture availability. Collected animals will be humanely euthanized by thoracic compression and will be placed on ice until dissected for collection of the liver. After dissection, the remainder of the animal body will be buried on site if allowable.

Liver dissections will occur in a decontaminated glass pan using a sterilized scalpel. Dissection equipment will be cleaned with Alconox and triple rinsed with de-ionized water between samples. Sampling personnel will wear surgical gloves, replaced between samples. The weight, length, species, age, and sex of each individual will be recorded before dissection. Prior to incision, the center of each mouse will be cleaned with a chem.-wipe to remove dirt. Dissected livers will be placed in individual Ziploc freezer bags and stored in an ice cooler at 4˚ C until they can be frozen and sent to the laboratory. Sample bags will be labeled with unique sample identification, sample location, sample type, date and time of sample, sampler's initials, and sampler's company affiliation.

A permanently bound weatherproof field note book will be used to document field activities, sample acquisition, and field conditions at the time of sampling. All small mammals captured will be recorded in the notebook whether collected or not (i.e., species, age, sex, location, collected or released). Information will be recorded in waterproof ink on consecutively numbered pages. Information will include project name and number, location of sample site, date and time of sample collection, sample identification numbers, description of samples and number of samples collected, field measurements, field observations and weather conditions, and personnel present. Changes or deletions to a record will be recorded with a single strike out and sampler's initials.

3.12 SURVEY AND GLOBAL POSITIONING SATELLITE INFORMATION

A survey subcontractor will survey according to State of Montana requirements for surveying monitoring wells. It requires that an initial survey of ground water monitoring well elevations be completed by a licensed surveyor registered in the State of Montana as defined under Title 37, chapter 67, Montana Codes Annotated. The vertical elevation must be based on the National Geodetic Vertical Datum of 1988 as referenced from a nearby U.S. Geological Survey marker, U.S. Coast and Geodetic Survey marker, or other similar marker if available. The vertical survey of the monitoring wells themselves must be accurate to the Fourth Order Class A (0.10 feet x square root of total distance of level loop in miles) with a measurement precision of 0.01 feet.

For all other sampling locations, field personnel will use hand held global positioning satellite (GPS) units. Each GPS unit will be set to read coordinates in meters and according to NAD83 Montana State Plane for resource-grade GPS units and to NAD83 UTM for recreational-grade GPS units.

3.13 SAMPLE SHIPPING

3.13.1 Chain-of-Custody Procedures

After samples have been collected, they will be maintained under strict chain-of-custody protocols. All sample containers collected for a particular media and sample location will be kept together in a plastic re-sealable bag and placed together in the same cooler. Groundwater, surface water, sediment, soil, and mine waste samples will be chilled to 4°C in coolers filled with doubled re-sealable bags filled with ice.

The field sampling personnel will complete a chain-of-custody record (COC) form for each shipping container (i.e., cooler, ice chest or other container) of samples to be delivered to the laboratory for analysis. In addition, a separate chain-of-custody will be filled out per media (i.e., one for surface water, one for groundwater, one for mine waste, etc.). The sampler is responsible for initiating and filling out the COC form. The COC will be signed by the sampler when he or she relinquishes the samples to anyone else. The COC for a shipping container will list only those samples in that shipping container. Information contained on the triplicate, carbonless COC form will include the following:

- Project number;
- Date and time of collection;
- Sample identification number;
- Sample type;
- Analyses requested;
- Number of containers/bags for each sample;
- Sampler's signature and affiliation;
- Signature of persons relinquishing custody, dates, and times;
- Signature of persons accepting custody, dates, and times;
- Method of shipment;
- Shipping air bill number (if the samples are shipped);
- Condition of samples and cooler temperature upon receipt by laboratory; and
- Any additional instructions to the laboratory.

The sample collector will cross out any blank spaces on the COC below the last sample number listed. Each sample container will be carefully packaged in a shipping container, typically an ice chest, with Styrofoam® peanuts, vermiculite or other packing material to reduce mechanical degradation during shipment. A labeled temperature blank may also be included with each cooler shipped, if temperature-sensitive samples were collected. Custody seals will be attached to the outside of the cooler or shipping container to ensure that the container cannot be opened without breaking the seal, and will be signed and dated by the sample custodian prior to shipment. If the custody seal is broken, the laboratory will immediately notify Tetra Tech.

The sampling personnel whose signature appears on the COC is responsible for the custody of the samples from the time of sample collection until custody of the samples is transferred to a designated laboratory, a courier, or to another project employee for the purpose of transporting the sample to the designated laboratory. The sample is considered to be in custody when the sample is: (1) in the direct possession of the sample custodian; (2) in plain view of the sample custodian; or (3) is securely locked in a restricted-access area by the sample custodian.

Custody is transferred when both parties to the transfer complete the portion of the COC under "Relinquished by" and "Received by." Signatures, printed names, company names, dates and times are required. Upon transfer of custody, the sampling personnel who relinquished the samples will retain the third sheet (pink copy) of the COC. When the samples are shipped by a common carrier, a Bill of Lading supplied by the carrier will be used to document the sample custody, and its identification number will be entered on the COC. Copies, receipts and carbons of Bills of Lading will be retained as part of the permanent documentation in the project file. It is not necessary for courier personnel to sign the COC.

When the samples are received by the analytical laboratory, the COC will be immediately signed along with the date and time of receipt. The top sheet (white copy) or a copy of the COC may be returned with the final analytical report. The laboratory will follow appropriate chain-of-custody procedures when shipping any samples to a subcontracted laboratory for analysis.

Upon receipt by the laboratory, the samples will be inspected for sample integrity and preservation, including temperature. The COC will be reviewed to verify completeness. Any discrepancies between the COC and sample labels and any problems noted upon sample receipt will be communicated immediately to Tetra Tech. The laboratory will store the samples in a specially designated area which is clean and maintained at the appropriate preservation temperature, if necessary. The laboratory will be responsible for following their internal custody procedures from the time of sample receipt until sample disposal.

3.13.2 Laboratories

Surface water, groundwater, sediment, soil, mine waste, macroinvertebrate, mammal, and vegetation tissue samples will be hand delivered to Energy Laboratories in Helena, Montana, for analysis.

Macroinvertebrate community samples will be shipped to EcoAnalysts, Inc. in Moscow, Idaho, an appropriate laboratory for benthic macroinvertebrate and periphyton taxon identification.

Samples will be hand delivered or shipped at the end of the sampling event, or sooner if required to meet holding time requirements. Chain-of-custody forms will accompany each cooler to the laboratory. Chain-of-custody forms will be filled out to include the project name, samplers name, sample number, date and time of sampling, number and type of bottles, and analytical parameter and method list. Samples will be stored and shipped in accordance with SOP-09 (Sample Packaging and Shipping). The chain-of-custody form that will be used for the project is included in **Appendix A-3**.

3.14 FIELD QUALITY CONTROL SAMPLES

Quality control (QC) samples will be collected during each sampling event and for each media sampled according to Tetra Tech SOP-13 (QC Samples). Section 4.0 provides additional QA/QC details and requirements. The following QC samples will be collected for surface water and groundwater:

Field Blanks (DI water) - Only one blank sample per matrix per day should be collected, but not to exceed the ratio of one blank for every 20 samples. This means that at least one blank will be collected per day per matrix. If more than 20 samples are collected in one day per matrix, then for each additional 20 samples, one additional blank will be collected. If 43 samples are collected for a particular matrix in one day, a total of three blanks will be collected and submitted for analysis. Equipment blanks may be substituted for field blanks. If field blanks are prepared, equipment rinsate blanks and trip blanks are not required under normal circumstances. Field blanks will be collected to evaluate whether contaminants have been introduced into the samples during the sampling procedures. Field blank samples will be obtained by pouring deionized water into a sampling container at the sampling point. The field blanks that are collected will be analyzed for metals. The field blanks will be preserved, packaged, and sealed in the manner described. A separate sample number and station number will be assigned to each sample, and it will be submitted blind to the laboratory.

Equipment rinsate blanks - Only one blank sample per matrix per day should be collected, but not to exceed the ratio of one blank for every 20 samples. This means that at least one blank will be collected per day per matrix. If more than 20 samples are collected in one day per matrix, then for each additional 20 samples, one additional blank will be collected. If 35 samples are collected for a particular matrix in one day, a total of two rinsate blanks will be collected and submitted for analysis. If equipment blanks are collected, field blanks and trip blanks are not usually required. Equipment rinsate blanks will be collected to evaluate field sampling and decontamination procedures by pouring deionized water over the decontaminated sampling equipment. One equipment rinsate blank will be collected per matrix each day that sampling equipment is decontaminated in the field. Equipment rinsate blanks will be obtained by passing water through or over the decontaminated sampling devices used that day. The rinsate blanks that are collected will be analyzed for metals.

Blind field standards - Blind field standards will be inserted in all media sample trains at a frequency of one per every sampling event per media. Blind field standards will be prepared by Resource Technology Corporation (RTC) in Laramie, Wyoming according to the supplier instructions. Blind field standards will be submitted for mine waste/soil, sediment, surface water, and groundwater. Field personnel will submit the solid samples to the laboratory for matching of approximate soil type. For surface water and groundwater, empty laboratory containers, consistent with those being used in the field, will be submitted to RTC for filling. RTC will return the samples within 2-3 days.

Field duplicate samples: Field duplicate samples will be collected for vegetation, small mammals, and macroinvertebrates at a frequency of one sample per 20 samples collected.

3.15 LABORATORY QUALITY CONTROL SAMPLES

Laboratory quality control samples will consist of calibration standards, laboratory control samples, method blanks, laboratory duplicates and matrix spikes. Laboratory QC samples will be prepared and analyzed at a frequency that is in accordance with the specified analytical method.

3.16 EQUIPMENT DECONTAMINATION

All water, soil, and sediment sampling equipment will be decontaminated according to Tetra Tech SOP-11 before sampling. Equipment decontamination consists of a tap water rinse, a soap and tap water wash, a dilute nitric acid (HNO_3) rinse (for samples designated for metals analysis), and a deionized water rinse followed by air drying. Equipment and instrumentation will be decontaminated between samples in the same manner.

4.0 QUALITY ASSURANCE PROJECT PLAN

This QAPP has been written to ensure the reliability of monitoring and measurement data. The Quality Assurance (QA) program for this project requires the generation of a site or project specific QAPP. The QAPP will identify instrument calibration procedures, preventative maintenance procedures, data reduction and validation procedures, and corrective actions. Guidance in the QAPP will enable field personnel to address quality issues in the field so that the majority of data collected meet the established data quality objectives.

4.1 INTRODUCTION

Tetra Tech prepared this QAPP for DEQ to guide quality assurance and quality control (QA/QC) procedures for completion of the RI at the UBMC.

This QAPP is a comprehensive document prepared to guide the RI along with the FSP. RI field activities for this project will include collection of samples and information for the following types of media:

- Groundwater
- Surface Water
- Sediment
- Vegetation
- Soil
- Macroinvertebrates
- Periphyton
- Small Mammals

Tetra Tech will complete a RI report that will present the methods of investigation, results of each field investigation task, an evaluation of the data, conclusions and recommendations for further remedial actions, further assessment, and a discussion of potential hazardous and deleterious substance migration routes and human and ecological receptors. The report will be complete with tables, figures, and analytical data reports, field forms, and boring and well logs. Analytical results for samples collected during assessments will be evaluated for precision, accuracy, representativeness, and completeness. Effective project management will ensure that the investigation approach is well defined and that sufficient data are collected to make decisions related to Facility remediation.

The sections in this introduction present the project organization and define the responsibilities of various project participants. This section also describes the data quality objectives (DQOs) for the assessments (overall goals of the project), defined to guide identification of specific tasks that will be used to collect the data necessary to support decision-making.

4.1.1 Project Organization

The overall project manager for DEQ is David Bowers, Project Officer in the Remediation Division. Allan Kirk is Tetra Tech's Project Manager for this project and will coordinate RI work. The descriptions below summarize project personnel and their associated responsibilities for the project.

DEQ Project Supervisor – David Bowers
Responsibilities: Coordination of project team, reviews all project planning documents and plans, ensures compliance with State requirements and guidelines.

Project Manager/Coordinator – Alan Kirk (Project Manager) Tetra Tech
Responsibilities: Project coordination and liaison with DEQ, property owners, and consulting team members. Assists in field planning, problem solving and decision making, quality assurance during project activities, prepares and reviews project documents. Reviews all chain-of-custody forms and analytical data and ensures analytical data meet current standards for accuracy and precision.

Assistant Project Manager – Natalie Morrow, Tetra Tech
Responsibilities: Project coordination, assists with communication between Tetra Tech and DEQ, property owners, and consulting team members. Assists in field planning and field activities, problem solving and decision making, quality assurance during project activities. Prepares and reviews documents.

Quality Assurance Officer – Mark R. Pearson, Tetra Tech
Responsibilities: Reviews all chain-of-custody forms and analytical data and ensures analytical data meet current standards for accuracy and precision. Performs data evaluation and data evaluation summary for all data collected during the RI. Reviews project documents.

Health and Safety Officer – Natalie Morrow, Tetra Tech
Responsibilities: Prepares health and safety plan (HASP) and ensures work crews comply with health and safety requirements.

4.1.2 Project Objectives

The objectives for this project are to:

- Review historic data in DEQ files to identify additional data gaps, if any.

- Identify specific data gaps for media at the Facility and develop a final SAP for the spring 2008 investigation to address the data gaps.
- Conduct a season-specific investigation during spring 2008 according to the FSP and QAPP.
- Evaluate and interpret data collected during 2007 and 2008 and prepare an RI report.

The above activities will be performed as part of the RI. Additional investigation work may be needed, as appropriate.

Project Schedule

This project involves completing a SAP and field work at the Facility. **Table A-4** outlines the estimated schedule of events and deliverable dates. The actual project schedule will depend on several factors, such as approval of the QAPP, and completion and approval of the season-specific SAP and HASP. The schedule will also depend upon the date investigation activities commence, unanticipated field and weather conditions, the need for further assessment, turn-around-time on analytical results, subcontractor availability, additional requirements by DEQ, and the length of the DEQ review and comment periods.

Tetra Tech will also provide the following:

- Weekly oral progress reports to DEQ. The reports will include the status of work and work progress, work plans for the upcoming week, any budget issues, problems encountered, and corrective actions taken.
- Monthly written status reports to DEQ that summarize work activities for the prior month and activities anticipated in succeeding months and percentage of work completed to date. The reports will also describe work progress, changes in personnel, description and purpose of travel costs, corrective actions taken, and schedule.

Project Description

The UBMC Facility is located approximately 15 miles east of Lincoln, Montana in Lewis & Clark County, Montana. The Facility is in a forested area at the headwaters of the Blackfoot River. Hillsides are steep and the valley narrow. The UBMC Facility includes several mines and tailings impoundments. The primary mines in the UBMC include, but are not limited to, the following:

- Anaconda
- Capitol
- Carbonate
- Consolation
- Edith
- Mike Horse
- Paymaster

The Mike Horse Mine is the largest of the mines in the UBMC. A large tailings impoundment is associated with the mine and is located along Beartrap Creek in the upper reaches of the drainage. Mining and milling activities in the area have resulted in the release of hazardous materials (heavy metals) to the environment. The largest release of heavy metals was in association with the 1975 tailings dam breach of the Mike Horse Tailings Impoundment.

This project will include various media sampling for the area extending from the UBMC mining area and the Blackfoot River to the Highway 279 Blackfoot River crossing located several miles downstream of the Mike Horse Mine (**Figure A-1**). The purpose of this project is to sample surface water, sediment, groundwater, soil, and aquatic organisms to evaluate metal/metalloid concentrations with the goal to address data gaps that exist following previous investigations at the Facility. This QAPP will be used together with the FSP and HASP to complete this project.

Tetra Tech will implement the field activities following approval of the FSP, QAPP, and HASP.

4.1.3 Data Quality Objectives

DQOs for this document were developed to ensure data quality and to define procedures for data collection. In addition, site-specific DQOs are identified below and were developed following the recommendations in EPA guidance documents (EPA 1998 and 2001). The DQO process allows Tetra Tech to determine the level of data quality required for the specific data collection activities and to estimate the costs associated with the activities.

Problem Statement

Review of previous investigations at the Facility resulted in the identification of possible data gaps that need to be addressed prior to developing a risk assessment, feasibility study, and remedial action plan. DEQ is interested in identifying the remaining data gaps that exist for the Facility and collecting additional data to address the data gaps. The goal is to provide information to identify areas that may require remediation and further sampling.

The media that will be sampled under this QAPP include the following:

- Groundwater
- Surface Water
- Sediment
- Vegetation
- Soil
- Macroinvertebrates
- Periphyton
- Small Mammals

The FSP presents details on the methods of investigation and specific investigation locations.

Decision Statement

The RI will involve collecting environmental data to support completion of a risk assessment, feasibility study, and remedial action plan. Remedial alternatives will likely focus on remediation or removal of routes of exposure to contaminated media by human and ecological receptors to assess the feasibility of remediation in various areas of the Facility. Tetra Tech will evaluate available data and make decisions based on the following decision statements:

- Are there portions of the Facility that do not require additional investigation?
- Are there portions of the Facility that have been remediated?
- Do the remediated areas present data gaps as to effectiveness of the remedial action?
- What media presents data gaps?
- Have any new potential sources of contamination been identified that have not been investigated?

Decision Inputs

Data required to address the decision statement may include physical and chemical characteristics of surface water, groundwater, sediment, soil, aquatic organisms, mammals and vegetation. Where enough data are available, data requirements may also include estimating waste volumes. Tetra Tech used information from previous investigations to develop this SAP. The information from previous investigations and this investigation will be used during the feasibility study to evaluate areas that require remedial action and to develop remedial alternatives. **Table A-15** summarizes the media that will be investigated, the parameters that will be evaluated, and the use of the data collected. The tables in the FSP (Section 3.0) provide specific details as to the list of metals and other field and laboratory analyses and data that will be collected and evaluated for this investigation for each media.

Study Boundary

The study boundary defined as the Facility for this investigation includes the UBMC Facility mine areas, the Upper Blackfoot River including the tributaries of Beartrap Creek, Mike Horse Creek, Anaconda Creek, Pass Creek, Stevens Gulch, Shave Gulch, and Paymaster Creek. The Facility also includes three marshes (Upper Marsh, Middle Marsh, and Lower Marsh) along the upper Blackfoot River and the Blackfoot River through and downgradient of the marshes to Highway 279. **Figure A-1** shows the approximate study boundary for this project. The study boundaries for surface water are each of the sampling points identified in the FSP. The vertical boundaries for the alluvial and bedrock borings will vary depending on conditions encountered and depth to groundwater. The vertical boundaries for soil depend on the area of investigation and specified sampling protocol in Section 3.0. Test pits completed in tailings and mine waste will be extended until native soil is encountered or until the mechanical limits of the backhoe have been reached. Tailings sample depths will be collected for the 0-2 inch, 2-12 inch, and 12-24 inch. Tailings will also be collected from the 12-inch depth interval just above the native soil contact and from the 12-inch depth interval within native soil just below the native soil-tailings contact. The vertical boundary for the remaining soil samples will be shallow and likely will not exceed 3 feet below ground surface (bgs). Hand excavated test pits for mine waste and edge of impacted area soil sampling will be limited to the 0- to 6-inch depth interval.

Decision Rule

Several different statistical parameters and regulatory standards will be used to evaluate data collected during the assessment (**Table A-16**). These include the following:

- Contaminants of potential concern (COPCs) in surface water, groundwater, soil, and sediment will be used to evaluate potential risks presented to human health and the environment.
- COPCs in aquatics, vegetation, and small mammals will be used to evaluate potential affects to ecological receptors within the study boundary for this project.

Comparison of Facility data to appropriate standards and screening levels will be completed to guide evaluation of areas with concentrations of COPCs in media that may present a risk to human and ecological health, and the environment. Media that may present a risk to human and ecological health, and the environment will be further evaluated for further assessment, site-specific risk assessment, and/or remedial action.

Tolerable Limits of Decision Errors

Decision errors are incorrect conclusions about a site caused by using data that are not representative of site conditions due to sampling or analytical error. Limits on decision error are typically established to control the affect of sampling and measurement errors on decisions regarding a site, thereby reducing the likelihood that an incorrect decision is made. The null hypothesis is that a site is contaminated. A false positive decision error is one that decides a site requires cleanup when, in actuality, it requires no cleanup. False positive and negative decision errors should be minimized as much as possible during this project.

Formal limits on decision error are not necessary in areas where the goal of the assessment is to define the boundaries of known contamination. This QAPP identifies specific field and laboratory methods and sampling strategies that reduce sampling error. The total study error will be reduced by collecting an appropriate number of environmental samples deemed necessary by the assessment team that are intended to represent the range of concentrations present at each site in question. The sampling program is designed to reduce sampling error by specifying an adequate number and distribution of samples to meet project objectives.

Tables A-4 through A-13 include the media to sample during this investigation and appropriate analytical methods. This QAPP specifies methods and protocols to reduce both field and laboratory error. It also specifies the requirements for collection of field quality control (QC) samples to facilitate assessment of data accuracy and precision. In addition, an individual SAP for the Facility will be prepared that specifies the sampling and analytical methods and protocols to reduce field error.

Sampling Design

The FSP portion of this SAP outlines the assessment design for the Facility. The FSP specifies sampling protocols, analytical methods and the types and numbers of samples to be collected during the investigation. The assessment design is based on a review of historical data and/or previous investigations completed at the Facility. The general sampling design for surface and subsurface soil is described below.

Surface Water – Surface water sample results will be used to evaluate concentrations of COPCs in surface water, identify potential sources of COPCs, and evaluate potential direct and indirect routes of exposure to human-health and the environment.

Groundwater – Groundwater sample results will be used to evaluate concentrations of COPCs in groundwater at the Facility and evaluate potential sources of COPCs and potential direct and indirect routes of exposure to human health and the environment.

Soil and Sediment – Soil and sediment sample results will be used to evaluate concentrations of COPCs in soil and sediment at the Facility. Results will also be used to identify potential direct and indirect routes of exposure to human-health and the environment, based on contaminant type and concentration, and potential site use scenarios. DEQ defines surface soil as soil between ground surface and 2 feet bgs and subsurface soil as soil greater than 2 feet bgs.

Macroinvertebrates – Sample results from the aquatics investigation will be used to evaluate the impacts of water quality on the types of macroinvertebrates and periphyton.

Vegetation – Sample results from the vegetation investigation will be used to evaluate the effects of mining to vegetation in the area and assess the effectiveness of mine waste removal and reclaimed in-place areas.

Small mammals – Sample results from the small mammal investigation will be used to evaluate potential effects of mining and mine wastes on small mammals in the UBMC.

4.2 MEASUREMENT DATA ACQUISITION

The following section describes tasks related to data acquisition. This includes the sampling process, QC procedures and requirements, equipment operation, data management, and record keeping.

4.2.1 Sampling Process

Detailed sampling process information is provided in the FSP section (Section 3.0) and summarized here. Field personnel will collect surface water, groundwater, sediment, soil, vegetation, small mammal, and aquatic samples during this investigation. Samples will be collected and analyzed as described in the FSP section, based on standard industry procedures and methods, and according to appropriate SOPs.

4.2.2 Quality Control

QC samples will include both field and laboratory samples, as described below.

Field Quality Assurance/Quality Control Sampling

Three types of field QC samples will be collected during this investigation. QC samples will include blind field standards, field blanks, and rinsate blanks. The purpose of analyzing QC samples is to meet DQOs specified in Section 4.1.3, above. **Table A-16** presents a summary of the field QA/QC objectives. Quality control (QC) samples will be collected during each sampling event and for each media sampled according to Tetra Tech SOP-13 (QC Samples). The following QC samples will be collected for surface water, groundwater, soil, and sediment:

Field Blanks (DI water) - Only one blank sample per matrix per day should be collected, but not to exceed the ratio of one blank for every 20 samples. This means that at least one blank will be collected per day per matrix. If more than 20 samples are collected in one day per matrix, then for each additional 20 samples, one additional blank will be collected. If 43 samples are collected for a particular matrix in one day, a total of three blanks will be collected and submitted for analysis. Equipment blanks may be substituted for field blanks. If field blanks are prepared, equipment rinsate blanks and trip blanks are not required under normal circumstances. Field blanks will be collected to evaluate whether contaminants have been introduced into the samples during the sampling procedures. Field blank samples will be obtained by pouring deionized water into a sampling container at the sampling point. The field blanks that are collected will be analyzed for metals. The field blanks will be preserved, packaged, and sealed in the manner described. A separate sample number and station number will be assigned to each sample, and it will be submitted blind to the laboratory.

Equipment rinsate blanks - Only one blank sample per matrix per day should be collected, but not to exceed the ratio of one blank for every 20 samples. This means that at least one blank will be collected per day per matrix. If more than 20 samples are collected in one day per matrix, then for each additional 20 samples, one additional blank will be collected. If 35 samples are collected for a particular matrix in one day, a total of two rinsate blanks will be collected and submitted for analysis. If equipment blanks are collected, field blanks and trip blanks are not usually required. Equipment rinsate blanks will be collected to evaluate field sampling and decontamination procedures by pouring deionized water over the decontaminated sampling equipment. One equipment rinsate blank will be collected per matrix each day that sampling equipment is decontaminated in the field. Equipment rinsate blanks will be obtained by passing water through or over the decontaminated sampling devices used that day. The rinsate blanks that are collected will be analyzed for metals.

Blind field standards - Blind field standards will be inserted in all media sample trains at a frequency of one per every sampling event per media. Blind field standards will be prepared by Resource Technology Corporation (RTC) in Laramie, Wyoming according to the supplier instructions. Blind field standards will be submitted for mine waste/soil, sediment, surface water, and groundwater. Field personnel will submit the solid samples to the laboratory for matching of approximate soil type. For surface water and groundwater, empty laboratory containers, consistent with those being used in the field, will be submitted to RTC for filling. RTC will return the samples within 2-3 days.

<u>Field duplicate samples</u>: Field duplicate samples will be collected for vegetation, small mammals, and macroinvertebrates at a frequency of one sample per 20 samples collected.

Ten percent (10%; one sample per every 10) of samples analyzed by XRF will be submitted for laboratory analysis for the constituents listed in **Table A-12**. No field duplicates will be collected for this investigation. The blind field standards will be submitted in place of the duplicates.

Laboratory Quality Assurance/Quality Control

Laboratory quality control procedures for Energy Laboratories of Helena, Montana and EcoAnalyst of Moscow, Idaho can be provided upon request.

Equipment Operation, Calibration, and Standardization

All field and laboratory equipment will be operated, maintained, calibrated, and standardized in accordance with EPA and manufacturer’s recommended procedures. Tetra Tech’s applicable SOPs that specify field equipment operation, maintenance, calibration, and standardization procedures are contained in **Appendix A-2**. **Tables A-4** and **A-5, A-6, A-7, 3-11, A-12**, and **A-13** prescribe the analytical methods that will be used for each media type. The selected analytical method(s) define QC requirements and how the laboratory must analyze each sample. The QC manual for Energy Laboratories, Inc. in Helena, Montana is available upon request.

4.2.3 Data Management

Analytical data will be provided to Tetra Tech in both electronic and hard copy. Hard copy reports will be stored in the project files. Analytical laboratory data for the project will be downloaded or entered directly into a Microsoft Access or Excel database. Tetra Tech will manually enter field parameter measurements into the database. Backups will be created prior to entry of new data in the database to prevent loss of data during the data reduction process. Any electronic survey or global positioning system (GPS) data will be archived in the same manner as electronic analytical data. Field descriptions of lithologic characteristics, observations, and other site data will be entered onto appropriate field forms during the field investigation and filed in designated project files in Tetra Tech's office.

The QA officer will maintain quality control of data transfer into the database by verifying the accuracy of a minimum of 10% of the entries placed in the database. If any errors are encountered, 100% of the data entries will be verified for accuracy.

4.2.4 Documents and Records

The QA Officer will be responsible for ensuring that project personnel have the current versions of the SAP and QAPP and other project planning documents. The Tetra Tech project manager will also maintain current project files and project documents.

4.3 ASSESSMENT AND OVERSIGHT ELEMENTS

The Project Coordinator and Quality Assurance Officer will be responsible for assessment and oversight of project activities. The DEQ Project Supervisor will be updated weekly and be provided a summary of project activities to date. A written project summary will also be prepared and provided the DEQ on a monthly basis.

An internal audit of field procedures may be performed by the Quality Assurance Officer. If completed, the internal audit will include a review of procedures selected for the sampling program, a review of the QA/QC samples required, and a review of training requirements. The laboratory is required to have written procedures addressing internal QA/QC as specified in the Comprehensive Environmental Response Compensation Liability Act (CERCLA) Contract Laboratory Program (CLP) protocol.

Corrective actions will be taken promptly upon identification of potential problems with data acquisition or measurement. Field equipment malfunctions will be identified promptly and corrected by the field team leaders. Corrective actions will be documented in the field notes. Laboratory equipment malfunctions are handled according to EPA analytical method specifications. Laboratory QC samples (calibration samples, method blanks, matrix spike samples, laboratory control samples, and laboratory duplicates) will be handled according to

EPA analytical method specifications and the Contract Lab Program protocol. Laboratory corrective actions will be included on analytical laboratory reports.

4.4 DATA REVIEW, VERIFICATION, AND VALIDATION

Data reduction, the result of grouping similar QC samples and calculating and reporting their recoveries, will be performed on laboratory data while still in the laboratory. Tetra Tech personnel will work directly with the laboratory's data QA Officer who will review all analytical data associated with each sample. Tetra Tech will receive all QA/QC reports from the analytical laboratory.

The types of laboratory QC data review will include calibration standards, calibration verification, laboratory controls, laboratory duplicates, and laboratory spikes. When EPA methods are used, the applicable data reduction procedures called for in the EPA methods will be used. The assessment reports will include the raw data and a summary of QC data reduction.

4.4.1 Data Review

The ability of data to meet DQOs is evaluated with a precision, accuracy, representativeness, completeness, and comparability (PARCC) statement. A PARCC statement is generated during data evaluation. The following sections define the terms used in the PARCC statement.

4.4.2 Precision

Precision is the amount of scatter or variance that occurs in repeated measurements of a particular analyte. Precision acceptance and rejection for this project will be based on the relative percent difference (RPD) of the field duplicates. Tetra Tech will evaluate analyte results for the field and duplicate soil samples using the RPD between the two samples when both values of the field/duplicate pair are greater than five times the practical quantitation limit (PQL) for a give analyte.

The RPD is given by:

$$\text{RPD (\%)} = \frac{2\,|S_1 - S_2|}{S_1 + S_2} \times 100$$

Where: | | = absolute value of S1 – S2

S_1 = measured field sample concentration; and
S_2 = measured duplicate sample concentration.

Blind field standards are samples of known concentration with established control limits, obtained from a third-party vendor (i.e., not prepared by the field team or the analytical laboratory). Standards provide a check on the accuracy of laboratory analyses through a comparison of laboratory results to the established control limits. The range of acceptable RPDs for precision is presented in **Table A-17**.

4.4.3 Accuracy

Accuracy is defined as the ability of the analytical procedure to determine the actual or known quantity of a particular substance in a sample. Accuracy acceptance or rejection will be based on the percent recovery (%R) of the matrix spike (MS) for soil samples and will be based on the percent recovery of the laboratory control sample (LCS) for solid samples. To determine accuracy, the %R for each MS or LCS will be compared to the acceptable range as specified in the applicable laboratory method. Equipment and laboratory blanks may also be analyzed to quantify artifacts introduced during sampling, transport, or analysis that may affect the accuracy of the data. In addition, initial and continuing calibration results may be used to verify that the sample concentrations are accurately measured by the analytical instrument.

The percentage recovery for MS samples is given by:

$$\text{Recovery (\%)} = \frac{A - B \times 100}{T}$$

Where: A = measured concentration of the spiked sample;
B = concentration of un-spiked sample; and
T = amount of spike added.

Field sample results associated with percent recoveries outside acceptable limits will be considered estimated. Field sample results associated with percent recoveries of less than 50% will be considered rejected, as recommended by EPA (2004). An overall assessment of accuracy will be made upon completion of the project. Overall accuracy will be stated as the mean %R. Because of the small number of matrix spike and laboratory control samples anticipated, no confidence interval will be calculated. The range of acceptable accuracy is presented in **Table A-17**.

4.4.4 Representativeness

The objective in addressing representativeness is to assess whether information obtained during the investigation accurately represents site conditions. Laboratory water blanks, field blanks, and rinsate blanks are used to assess representativeness. Field results associated with contaminated blanks will be considered estimated, with a high bias, when the field sample result is greater than the practical quantification limit but less than five times the contaminant concentration, as recommended in EPA (2004).

If a laboratory blank contains detectable levels of common laboratory contaminants, then the sample results will be considered as positive only if the concentrations in the sample exceed 10 times the maximum amount detected in any blank. If the concentration in the sample is less than 10 times the blank concentration, we will conclude that the chemical was not detected in the sample and will consider the blank-related concentrations of the chemical to be the quantification limit for the chemical in that sample. If all samples contain levels of a common laboratory contaminant at less than 10 times the contamination noted in the blank, then the analyte will be eliminated from the set of sample results.

4.4.5 Completeness

The objective in addressing completeness is to assess whether enough data have been collected and enough data are valid to meet the investigation needs. Completeness is assessed by comparing the number of valid sample results to the number of samples collected. The completeness goal of the project is 90%.

Percentage completeness (C) is given by:

$$C\ (\%) = \frac{V}{P} \times 100$$

Where: V = number of valid measurements/data points obtained; and
P = number of measurements/data points planned.

4.4.6 Comparability

The objective in addressing comparability is to assess whether one set of data can be compared to another set of data. Comparability is assessed by determining if an EPA-approved method was used, if values and units are sufficient for the database, if specific sampling points can be established and documented, and if field collection methods were similar.

4.4.7 Data Validation and Evaluation

Data validation consists of completing a review of data using the raw analytical data. The laboratory will validate raw laboratory data using EPA CLP National Functional Guidelines (EPA 2004) and according to specific analytical method requirements. Data evaluation consists of completing a review of laboratory analytical reports that have already had internal laboratory validation of the raw data. The objective of the data validation and evaluation is to identify any unreliable or invalid laboratory measurements and qualify data for interpretive use. For this project, the analytical laboratory will perform data validation on raw analytical data prior to preparing a final analytical report. Once the laboratory has prepared and submitted a final analytical report, the project personnel will complete an evaluation of the data. The data evaluation will include review of field QA/QC data and additional review of qualifiers assigned to the data by the analytical laboratory. Additional qualifiers will be assigned to the data as necessary based on, but not limited to, precision and accuracy of results, blank contamination, and holding time exceedances. **Table A-18** presents the data qualifiers that will be assigned to results, as necessary.

Project personnel will complete data evaluation checklists. The checklists provide a guide for review of the laboratory and field procedures and data collected. Tetra Tech will use the DEQ-provided checklist for the evaluation. The review will evaluate whether the following were completed according to SAP/QAPP requirements, EPA guidelines and/or method specifications:

- Chain-of-custody procedures;
- Cooler temperatures;
- Holding times;
- Laboratory QA/QC (method blanks, control samples, duplicates, MS/MSD); and
- Field QA/QC (sample handling, duplicates, and field and equipment blanks).

Knowing the limitations of the data assists the data user when making interpretations. Data with limitations are useable for evaluation as long as the limitations are considered. Evaluation of other field data (pH and specific conductance, for example) is not possible because these data have very limited statistical control limits. Professional judgment is required and will be used to assess the impact of field QC on the overall quality and usability of the field data.

4.4.8 Data Reconciliation

Data reconciliation is performed in the office after data validation is complete. Data reconciliation is the generation of the PARCC statement that assesses the data relative to meeting the DQOs. Tetra Tech will perform this reconciliation as part of the data evaluation and completion of the data evaluation checklist. Using the PARCC statement as a basis, reconciliation of data evaluation will be done by comparing evaluation results with project objectives. If data user requirements are not met, the Tetra Tech project manager and quality assurance manager will confer with DEQ on how issues will be resolved and how limitations of the data will be reported.

5.0 REFERENCES

Barbour, M., J. Gerritsen, B. Snyder and J. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish. Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency, Office of Water. Washington, D.C.

Herbert, C.D., Elwell, M.R., Travlos, G.S., Fitz, C.J., and Bucher, J.R., 1993. Subchronic toxicity of cupric sulfate administered in drinking water and feed to rats and mice. Fund. Appl. Toxicol. 21:461-475.

Klemm, D.J., P.A. Lewis, F. Fulk, and J.M. Lazorchak. 1990. Macroinvertebrate Field and Laboratory Methods for evaluating the Biological Integrity of Surface Waters. EPA/600/4-90/030. U.S. Environmental Protection Agency.

Montana Department of Environmental Quality (2006). Action Level for Arsenic in Surface Soil. Remediation Division. Dated April 2005.

Montana Department of Environmental Quality (2006). Sample Collection, Sorting, and Taxonomic Identification of Benthic Macroinvertebrates. Montana Department of Environmental Quality, Water Quality Planning Bureau, Standard Operating Procedure: WQPBWQM-009.

Montana DEQ (2007a). 2007. Final Comprehensive Data Summary Report for the Upper Blackfoot Mining Complex, Lewis and Clark County, Montana. December 2007.

Montana DEQ (2007b). Remedial Investigation Work Plan, Upper Blackfoot Mining Complex, Lewis and Clark County, Montana. December 2007.

Pershagen, G. and Vahter, M., 1979. Arsenic: a toxicological and epidemiological appraisal. Naturvardsverket. Rapp. SNV PM 1138, Liber.

Schlicker, S.A., and Cox, D.H., 1968. Maternal dietary zinc, and development and zinc, iron, and copper content of the rat fetus. J. Nutr. 95: 287-294.

Steward, D., J. Luther, P. Carroll, L. Vicklund, G. Vance, and L. Spackman. 1994. Standard operating procedures for sampling selenium in vegetation. University of Wyoming, Agriculture Experiment Station, Department of Plant, Soil, and Insect Sciences. MP-77.

U.S. Department of Energy (1995). Preliminary remediation goals for use at the U. S. Department of Energy Oak Ridge Operations Office. ES/ER/TM-106, Risk Assessment Program, Health Sciences Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

U.S. Department of Energy (1997). Preliminary Remediation Goals for Ecological Endpoints. ES/ER/TM-162/R2. Prepared for Office of Environmental Management by Lockheed Martin Energy Systems. Dated August 1997.

U.S. Environmental Protection Agency (1998) Guidance for the Data Quality Objectives Process. EPA QA/G-4; EPA/600/R-96/055. September 1998. 69 pp.

U.S. Environmental Protection Agency (2001). EPA Requirements for Quality Assurance Project Plans. EPA QA/R-5; EPA/240/B-01/003. March 2001.

U.S. Environmental Protection Agency (2004) Preliminary Remediation Goals. EPA Region 9. Table dated October 2004.

U.S. Environmental Protection Agency (2004). Draft Final, USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. OSWER 9240.1-45, EPA 540-R-04-004. July 2004.

Washington State Department of Ecology (1997). Creation and Analysis of Freshwater Sediment Quality Values in Washington State. Publication No. 97-323a.

Wilson, R.H., DeEds, F., Cox, A.J., 1941. Effects of continued cadmium feeding. Sandford University School of Medicine. Food Research Unit. 222-235.

Woodbury, P., G. Rubin, D. McCune, L. Weinstein, and E. Neuhauser. 1999. Assessing trace element uptake by vegetation on a coal fly ash landfill. Water, Air, and Soil Pollution. Vol. 111, No. 1-4, pg. 271-286.

Wyoming Department of Environmental Quality, Land Quality Division. Updated 1997. Guideline No. 2 – Vegetation.

TABLES

Table A-1
Sampling Summary for Surface Water, Sediment, and Macroinvertebrate Sampling Locations

Location Information					Investigation Type						Surface Water Analyses			Sediment Analyses	Aquatics Analyses		
Line Entry	Surface Water Body	Location Type (s)	Station Number	Media Type	Sediment Sample Depth Intervals	Proposed Sample ID	Source	Nature and Extent, and Risk	RD	Stream Gage (General Location)	Field[1]	Common Anions and Cations[2]	Metals[3]	Metals[4]	Taxonomy	Metals	Rationale / Comments
1	MH	SW	BRSW-4	SW	--	--	X	X	X	above anticipated seepage area, at station location, below anticipated seepage area but above confluence with Beartrap Creek/tailings outfall	X	X	X	--	--	--	Evaluate potential loading from seeps and waste removal areas.
2	MH	SW	BRSW-44	SW	--	--	X	X	X	above anticipated seepage area, at station location, below anticipated seepage area but above confluence with Beartrap Creek/tailings outfall	X	X	X	--	--	--	Evaluate loading from tailings deposits and tailings dam seeps.
3	BC	SW	BRSW-23	SW	--	--	X	X	X	above waste piles, at sample location, below waste piles	X	X	X	--	--	--	Evaluate potential metals loading from tailings and mine waste deposits.
4	BC	SW	BRSW-39A	SW	--	--	X	X	X	at station location	X	X	X	--	--	--	Evaluate loading from tailings and mine waste deposits.
5	AC	SW, SE, AQ	BRSW-6	SW, SE, AQ		--	X	X	X	at station location	X	X	X	X	X	X	Good water quality stream. Evaluate stream as possible background or reference stream for water, sediment, and aquatic organisms.
6	BR	SW	BRSW-29	SW	--	--	X	X	X	at station location	X	X	X	--	--	--	Evaluate potential metals loading and possible change in concentration following confluence of Anaconda Creek.
7	BR	SW	AW-003	SW	--	--	X	X	X	at station location	X	X	X	--	--	--	Evaluate metals load from constructed wetlands outflow.
8	BR	SW, SE, AQ	BRSW-109	SW, SE, AQ	0-2"	BRSW-109	X	X	X	at station location	X	X	X	X	X	X	Evalute metals in water and sediment from potential loading from tailings/mine waste. Evaluate affects on aquatics
9	BR	SW, SE	BRSW-9	SW, SE	0-2"	--	X	X	X	at station location	X	X	X	X	--	--	Evaluate metal load in water and sediment on Blackfoot River above confluence with Stevens Creek
10	BR	SW, SE, AQ	BRSW-108	SW, SE, AQ	0-2"	BRSW-108	X	X	X	at location and on Stevens Creek	X	X	X	X	X	X	Evalaute metal in water and sediment following Blackfoot River below confluence with Stevens Creek. Evaluate affect on aquatics
11	BR	SW, SE	BRSW-36	SW, SE	0-2"	--	X	X	X	at station location	X	X	X	X	X	X	Evaluate metal load in water and sediment above Shave Creek. Evaluate affects on aquatics
12	BR	SW, SE, AQ	BRSW-33	SW, SE, AQ	0-2"	--	X	X	X	at station location	X	X	X	X	X	X	Evaluate metal load to water and sediment below Shave Creek. Evaluate affects on aquatics.
13	BR	SW, SE, AQ	BRSW-12	SW, SE, AQ	0-2"	--	X	X	X	at station location	X	X	X	X	X	X	Evalaute metal load in water and sediment prior to entering marsh. Evaluate affects on aquatics.
14	PD	SW, SE, AQ	BRSW-11	SW, SE, AQ	0-2"	--	X	X	X	at station location	X	X	X	X	X	X	Evaluate possible background metals concentrations in water and sediment from Pass Creek. Evaluate health of aquatics.

Table A-1
Sampling Summary for Surface Water, Sediment, and Macroinvertebrate Sampling Locations

Location Information						Investigation Type				Surface Water Analyses			Sediment Analyses	Aquatics Analyses		
Line Entry	Surface Water Body	Location Type (s)	Station Number	Media Type	Sediment Sample Depth Intervals	Proposed Sample ID	Source	Nature and Extent, and Risk	RD	Stream Gage (General Location)	Field[1]	Common Anions and Cations[2]	Metals[3]	Metals[4]	Taxonomy	Metals	Rationale / Comments
15	PM	SW, SE, AQ	BRSW-21	SW, SE, AQ	0-2"	--	X	X	X	at station location	X	X	X	X	X	X	Evaluate metal load in water and sediment from Paymaster Creek. Evaluate affect on aquatics.
16	PM	SW, SE, AQ	BRSW-13	SW, SE, AQ	0-2"	--	X	X	X	at station location	X	X	X	X	X	X	Evaluate metal load in water and sediment from Paymaster Creek. Evaluate affect on aquatics.
17	BR	FW	BMSP-2	FW	--	--	X	X	X	at station location	X	X	X	--	--	--	Possible abandoned flowing exploration well in marsh. Sample if flowing, note if abandonned.
18	BR	SW, SE, AQ	BRSW-110	SW, SE, AQ	--	BRSW-110	X	--	X	at station location	X	X	X	X	X	X	Evaluate chemistry of surface water & sediment in marsh near BMSP-2. Evaluate aquatic organisms
19	BR	SW, SE, AQ	BRSW-107	SW, SE, AQ	0-2"	BRSW-107	X	X	X	at station location	X	X	X	X	X	X	Evaluate metal load in water and sediment in Upper Marsh. Evaluate affects on aquatics.
20	BR	SW, SE	BRSW-31	SW, SE	0-2"	--	X	X	X	at station location	X	X	X	X	--	--	Evaluate metals in water and sediment below the confluence with Swamp Creek, Meadow Creek, and Porcupine Creek
21	BR	SW, SE, AQ	BRSW-106	SW, SE, AQ	0-2"	BRSW-106	X	X	X	at station location	X	X	X	X	X	X	Evaluate metal load in water and sediment above confluence with Surveyor Gulch. Evaluate aquatic organisms.
22	BR	SW, SE	BRSW-105	SW, SE	0-2"	BRSW-105	X	X	X	at station location	X	X	X	X	--	--	Evaluate metal load in water and sediment above Middle Marsh.
23	BR	SW, SE, AQ	BRSW-16	SW, SE, AQ	0-2"	--	X	X	X	at station location	X	X	X	X	X	X	Evaluate metal load in water and sediment within central portion of Middle Marsh. Evaluate affects on aquatics.
24	BR	SW, SE, AQ	BRSW-104	SW, SE, AQ	0-2"	BRSW-104	X	X	X	at station location	X	X	X	X	X	X	Evaluate metal load in water and sediment between Middle March and Lower Marsh. Evaluate aquatic organisms.
25	BR	SW, SE, AQ	BRSW-103	SW, SE, AQ	0-2"	BRSW-103	X	X	X	at station location	X	X	X	X	X	X	Evaluate metal load in water and sediment within central portion of Lower Marsh. Evaluate affects on aquatics.
26	BR	SW, SE, AQ	BRSW-17	SW, SE, AQ	0-2"	--	X	X	X	at station location	X	X	X	X	X	X	Evaluate metal load in water and sediment below Lower Marsh. Evaluate affects on aquatics.
27	BR	SW, SE, AQ	BRSW-102	SW, SE, AQ	0-2"	BRSW-102	X	X	X	at station location	X	X	X	X	X	X	Evaluate metal load in water and sediment approximately mid-way between Lower Marsh and Highway 279. Evaluate affects on aquatics.
28	BR	SW, SE, AQ	BRSW-101	SW, SE, AQ	0-2"	BRSW-101	X	X	X	at station location	X	X	X	X	X	X	Evaluate metal load in water and sediment upstream of Highway 279 bridge. Evaluate affects on aquatics.

NOTES:
1 - Field parameters include: dissolved oxygen, temperature, pH, specific conductance, and flow gagaing
2 - Anions & Common cations include: sulfate, bicarbonate, carbonate, chloride, calcium, magnesium, potassium, sodium
3 - Metals (surface water) include: alumium, arsenic, cadmium, copper, iron, lead, manganese, zinc
4 - Metals (Sediment and Aquatics) - arsenic, cadmium, copper, lead, manganese, mercury, zinc

Drainage Basin
BR-Blackfoot River
BC-Beartrap Creek
MH-Mike Horse Creek
PD-Pass Creek Meadow
AC - Anaconda Creek

Media
SE - Sediment
SW - Surface Water

AQ - Aquatics (macroinvertebrates, periphyton, etc.)
FW - Flowing Well

Table A-2 Surface Water Field Parameters			
Parameter	**SOP Number[(1)]**	**SOP Title**	**Event**
Dissolved Oxygen	SOP-08	Field Measurement of Dissolved Oxygen	All
Specific Conductance	SOP-05	Field Measurement of Specific Conductance	All
pH	SOP-06	Field Measurement of pH	All
Water Temperature	SOP-07	Field Measurement of Water Temperature	All
Flow	SOP-01	Streamflow Measurement; Wading Technique	All

1 Tetra Tech Standard Operating Procedures (Appendix A-2)

Table A-3 Surface Water Sampling Requirements		
Parameter	**Preservation[(1)]**	**Bottle Size/Type**
Total Recoverable Metals	HNO3 to pH < 2; Iced to 4°C	250 milliliter polyethylene
Dissolved Metals (aluminum only)	Filtered through 0.45 micron filter; HNO3 to pH < 2; Iced to 4°C	250 milliliter polyethylene
Common Ions/Physicochemical	Iced to 4°C	500 milliliter polyethylene

1 HNO3 = nitric acid

Table A-4 Surface Water Analytical Requirements			
Parameter	**PQL (mg/L)[(1)]**	**EPA Method No.**	**Max. Holding Time**
Physicochemical			
Specific Conductivity	None	2510B	28 days
pH	None	150.1/4500-H+B	Upon arrival at lab
Total Dissolved Solids	None	2540C	7 days
Total Suspended Solids	None	160.2/2540D	7 days
Hardness	None	2340B	6 months
Acidity	None	305.1/2310B	14 days
Metals[(2)]			
Aluminum (dissolved)	0.03	200.8/200.7	6 months
Arsenic	0.002	200.8/200.7	6 months
Cadmium	0.00008	200.8/200.7	6 months
Copper	0.001	200.8/200.7	6 months
Iron	0.01	200.8/200.7	6 months
Lead	0.0005	200.8/200.7	6 months
Manganese	0.003	200.8/200.7	6 months
Zinc	0.01	200.8/200.7	6 months
Common Cations[(2)]			
Calcium	1.0	200.8/200.7	6 months
Magnesium	1.0	200.8/200.7	6 months
Potassium	1.0	200.8/200.7	6 months
Sodium	1.0	200.8/200.7	6 months
Common Anions[(2)]			
Sulfate	None	375.2/4500-SO4 E	28 Days
Bicarbonate	None	2320B	14 Days
Carbonate	None	2320B	14 Days
Chloride	None	325.3/4500-Cl C	28 Days

1 PQL = Laboratory Practical Quantitation Limit in milligrams per liter (mg/L)

2 Surface water parameters will be analyzed for total recoverable metals, except aluminum. Aluminum will be analyzed for dissolved metals.

Table A-5 Streambed Sediment Analytical Requirements		
Parameter	**Method(1)**	**PQL(2)**
Total Aluminum (mg/kg)	SW-846 – 6020 /6010B	1
Total Arsenic (mg/Kg)	SW-846 – 6020 /6010B	0.5
Total Cadmium (mg/Kg)	SW-846 – 6020 / 6010B	0.5
Total Copper (mg/Kg)	SW-846 – 6020 / 6010B	0.5
Total Iron (mg/kg)	SW-846 – 6020 / 6010B	5
Total Lead (mg/Kg)	SW-846 – 6020 / 6010B	0.5
Total Manganese (mg/Kg)	SW-846 – 6020 / 6010B	0.5
Total Mercury (mg/Kg)	SW-846 – 7471	0.5
Total Zinc (mg/Kg)	SW-846 – 6020 / 6010B	0.5

1. SW-846 - Test Methods for Evaluating Solid Waste-Physical Chemical Methods (EPA, 1986)
2. PQL = Practical quantitation limit

Table A-6 Marsh Sediment Analytical Requirements		
Parameter	**Method(1)**	**PQL(2)**
Saturated Paste pH (s.u.) and Electrical Conductivity (mmhos/cm)	ASAM10-3	--
Total Organic Carbon	STD 501-034	--
Total Aluminum	SW-846 – 6020 / 6010B	1
Total Arsenic (mg/Kg)	SW-846 – 6020 / 6010B	0.5
Total Cadmium (mg/Kg)	SW-846 – 6020 / 6010B	0.15
Total Copper (mg/Kg)	SW-846 – 6020 / 6010B	0.5
Total Iron (mg/kg)	SW-846 – 6020 / 6010B	5
Total Lead (mg/Kg)	SW-846 – 6020 / 6010B	0.2
Total Manganese (mg/Kg)	SW-846 – 6020 / 6010B	10
Total Mercury (mg/Kg)	SW-846 – 7471	0.5
Total Zinc (mg/Kg)	SW-846 – 6020 / 6010B	2
Acid-Base Accounting & Synthetic Precipitation Leaching Procedure (½-of all marsh sediment samples will be analyzed for ABA and SPLP).		
Acid-Base Accounting	Modified Sobek	--
Synthetic Precipitation Leaching Procedure	EPA 1312	--

Note: XRF Screening will compare results to most stringent Ecological Risk Soil Screening Levels (EcoSSLs)

1. USDA Handbook 60 - Diagnosis and Improvement of Saline and Alkali Soils (USDA, 1954)
   Sobek - Field and Laboratory Methods Applicable to Overburdens and Minesoils (EPA, 1978)
   Methods of Soil Analysis - American Society of Agronomy, Parts I and II. Monograph No. 9 (1982)
   SW-846 - Test Methods for Evaluating Solid Waste-Physical Chemical Methods (EPA, 1986)
2. PQL = Practical quantitation limit.

Table A-7 Macroinvertebrate Tissue Analytical Requirements		
Parameter	**Method[1]**	**PQL[2]**
Total Arsenic (mg/kg)	SW-846 – 7062	0.5
Total Cadmium (mg/kg)	SW-846 – 6020	0.15
Total Copper (mg/kg)	SW-846 – 6020	0.5
Total Lead (mg/kg)	SW-846 – 6020	0.2
Total Manganese (mg/kg)	SW-846 – 6020	10
Total Mercury (mg/kg)	SW-846 – 7471	0.5
Total Zinc (mg/kg)	SW-846 – 6020	2

1. SW-846 - Test Methods for Evaluating Solid Waste-Physical Chemical Methods (EPA, 1986)
2. PQL = Practical quantitation limit. The PQLs listed are approximate and based on a 2 gram sample size. If the sample size is less than 2 grams, the PQL will increase according to the actual weight of the sample.

Table A-8
Summary of Monitoring Well and Piezometer Inventory

								Investigation Type[1]					Proposed Analyses					
Line Entry	General Location	Drainage Basin	Station Number	Media Type	Alluvial	Bedrock	Soil Sample Depth Intervals	Proposed Sample ID	Source	Nature and Extent	Risk	RD	Field[2]	Standard Analyte Suite[3]	Metals[4,L]	Water Levels[11]	Rationale / Comments	Estimated Total Depth (ft bgs)
1	At mouth of Porcupine Gulch / road to Meadow Gulch	BR	LCMW-1	GW	X	--	--	LCMW-1	--	X	X	--	X	X	X	X	Evaluate alluvial groundwater exiting UBMC	26
2	At mouth of Porcupine Gulch paired w/ LCMW-1	BR	BRGW-101	GW	--	X	--	BRGW-101	--	X	X	--	X	X	X	X	Evaluate bedrock groundwater exiting UBMC	85
3	Along Black Foot River at Mary P Prospect	BR	MPP-4	GW	X	--	--	MPP-4		X	X	--	X	X	X	X	Evaluate alluvial groundwater near Mary P Prospect paired w/ BRGW-110	
4	Along Black Foot River at Mary P Prospect	BR	BRGW-110	GW	--	X	--	BRGW-110	--	X	X	--	X	X	X	X	Evaluate bedrock groundwater near Mary P Prospect paired w/ MPP-4	41
5	At down stream end of Anaconda Mine constructed wetlands	BR	ANMW-7	GW	X	--	--	ANMW-7	X	X	X	--	X	X	X	X	Evaluate alluvial groundwater exiting the Anaconda Mine area and shallow Blackfoot River	22
6	Mouth of drainage near Highway 200	SW	LCMW-5	GW	X	--	--	LCMW-5	X	X	X	--	X	X	X	X	Evaluate alluvial groundwater exiting Carbonate Mine area	19
7	Mouth of drainage near Highway 200	SW	LCMW-12D	GW	X	--	--	LCMW-12D	X	X	X	--	X	X	X	X	Evaluate alluvial groundwater exiting Carbonate Mine area	30
8	Mouth of drainage near Highway 200	SW	LCMW-12S	GW	X	--	--	LCMW-12S	X	X	X	--	X	X	X	X	Evaluate alluvial groundwater exiting Carbonate Mine area	17
9	At top of Carbonate Mine repository	SW	SWGW-101	GW	X	--	--	SWGW-101	X	X	--	--	X	X	X	X	Alluvial well for repository monitoring	20
10	At bottom of Carbonate Mine repository paired w/ UCMW-11	SW	SWGW-102	GW	X	--	--	SWGW-102	X	X	X	--	X	X	X	X	Alluvial well for repository monitoring	20
11	Drainage bottom upstream of reclaimed area	SW	SWGW-103	GW	X	--	--	SWGW-103	--	X	--	--	X	X	X	X	Background well for mine reclamation area	20
12	At base or repository	SW	UCMW-11	GW	--	X	--	UCMW-11	X	X	--	--	X	X	X	X	Evaluate repository and bedrock groundwater	82
13	Paymaster mine	PM	PMMW-13	GW	X	X	--	PMMW-13	X	X	--	--	X	X	X	X	Alluvial bedrock interface with historic data in vicinity of mine site	18
14	Paymaster Mine	PM	PMMW-15	GW	X	--	--	PMMW-15	X	X	X	--	X	X	X	X	Alluvial well downstream of impacts	
15	Downgradient of Paymaster repository	PM	PMGW-116	GW	X	--	--	PMGW-116	--	X	--	--	X	X	X	X	Monitor downgradient of proposed repository expansion area	
16	Downgradient of Paymaster repository	PM	PMGW-117	GW	X	--	--	PMGW-117	--	X	--	--	X	X	X	X	Monitor downgradient of proposed repository expansion area	
17	Downstream of mine along edge of marsh paired w/ PMMW-119	PM	PMGW-118	GW	X	--	--	PMGW-118	--	X	--	--	X	X	X	X	Evaluate shallow groundwater downgradient of mine along edge of marsh system	40
18	Downstream of mine along edge of marsh paired w/ PMMW-118	PM	PMGW-119	GW	--	X	--	PMGW-119	--	X	--	--	X	X	X	X	Evaluate bedrock groundwater downgradient of mine along edge of marsh system	80
19	Paymaster mine near PMMW-15	PM	PMGW-120	GW	--	X	--	PMGW-120	X	X	X	--	X	X	X	X	Evaluate bedrock groundwater, in vicinity of gaining reach	60
20	Downstream of Mike Horse fault crossing in vicinity of veins	PM	PMMW-14	GW	X	--	--	PMMW-14	--	X	--	--	X	X	X	X	Alluvial well in vicinity of fault vein crossing drainage	22.5
21	Headwater reach	PM	PMPZ-4	GW	X	--	--	PMPZ-4	--	X	--	--	X	X	X	X	Alluvial well in headwaters of drainage to evaluate upstream of Mike Horse fault	8
22	Adjacent to county road in wet area	ED	EDP-2	GW	X	--	--	EDP-2	X	X	--	--	X	X	X	X	Evaluate shallow alluvial groundwater in vicinity of mining activities	25

Table A-8
Summary of Monitoring Well and Piezometer Inventory

Line Entry	General Location	Drainage Basin	Station Number	Media Type	Alluvial	Bedrock	Soil Sample Depth Intervals	Investigation Type[1]: Proposed Sample ID	Source	Nature and Extent	Risk	RD	Proposed Analyses: Field²	Standard Analyte Suite³	Metals[4,L]	Water Levels[11]	Rationale / Comments	Estimated Total Depth (ft bgs)
23	West of Edith Mine waste rock piles	ED	EDMW-2	GW	X	--	--	EDMW-2	X	X	--	--	X	X	X	X	Evaluate shallow alluvial groundwater in vicinity of mining activities	
24	Edith Mine generally between EDMW-2 and EDP-2	ED	EDGW-105	GW	--	X	--	EDGW-105	X	X	--	--	X	X	X	X	Evaluate bedrock groundwater in vicinity of mining activities	80
25	Lower Stevens Gulch at switchback paired w/ SGGW-102	SG	SGGW-101	GW	X	--	--	SGGW-101	--	X	--	--	X	X	X	X	Evaluate bedrock groundwater at mouth of drainage	40
26	Lower Stevens Gulch at switchback paired w/ SGGW-101	SG	SGGW-102	GW	--	X	--	SGGW-102	--	X	--	--	X	X	X	X	Evaluate bedrock groundwater at mouth of drainage	80
27	Upstream end of Anaconda Mine reclamation area	AN	ANWS-1	GW	X	--	--	ANWS-1	--	X	--	--	X	X	X	X	Evaluate alluvial groundwater entering the Anaconda Mine area	--
28	~1500 feet upstream of Anaconda Mine	BC	BCMW-10	GW	X	--	--	BCMW-10	--	X	--	--	X	X	X	X	Evaluate alluvial groundwater in vicinity of projected Blackfoot Fault crossing	16
29	~1500 feet downstream of Dam along main road	BC	BCGW-115	GW	X	--	--	BCGW-115	--	X	--	--	X	X	X	X	Evaluate Blackfoot Fault crossing of channel, evaluate gaining/loosing reach	200-250
30	At switchback in access road to Dam	MH	MHMW-8	GW	--	X	--	MHMW-8	--	X	X	--	X	X	X	X	Evaluate shallow bedrock near mouth of Mike Horse Creek	25
31	At switchback in access road to Dam paired w/MHMW-8	MH	MHMW-109	GW	X	--	--	MHMW-109	--	X	X	--	--	--	--	--	Evaluate alluvial groundwater leaving Mike Horse Creek drainage	15
32	~500 feet upstream of MHMW-8 at toe of repository near seep area. Paired w/ MHGW-113	MH	MHMW-112	GW	X	--	--	MHMW-112	X	X	X	--	--	--	--	--	Alluvial well to monitor repository	15
33	~500 feet upstream of MHMW-8 at toe of repository near seep area. Paired with MHGW-112	MH	MHMW-113	GW	--	X	--	MHMW-113	X	X	X	--	--	--	--	--	Bedrock well to monitor repository	40
34	Mike Horse Mine site above water treatment	MH	UMHMW-3	GW	--	X	--	UMHMW-3	X	X	--	--	--	--	--	--	Evaluate upstream end of gaining reach above water treatment facility	15
35	Mike Horse Mine site above water treatment paired w/UMHMW-3	MH	MHMW-115	GW	--	X	--	MHMW-115	X	X	--	--	--	--	--	--	Evaluate alluvial groundwater quality from mine waste rock seepage entering repository area	15
36	Upslope of Mike Horse Mine seepage area	MH	UMHMW-1D	GW	--	X	--	UMHMW-1D	X	X	--	--	--	--	--	--	Evaluate groundwater quality from mine tailings seepage	42.5
37	Upslope of Mike Horse Mine seepage area	MH	UMHMW-1S	GW	X	--	--	UMHMW-1S	X	X	--	--	--	--	--	--	Evaluate groundwater quality from mine tailings seepage	15
38	Upslope of Mike Horse Mine seepage area	MH	UMHMW-2D	GW	--	X	--	UMHMW-2D	X	X	--	--	--	--	--	--	Evaluate groundwater quality from mine tailings seepage	11.5
39	Upslope of Mike Horse Mine seepage area	MH	UMHMW-2S	GW	X	--	--	UMHMW-2S	X	X	--	--	--	--	--	--	Evaluate groundwater quality from mine tailings seepage	19.5
40	Upstream of Mike Horse Mine adits near spring	MH	MW-1	GW	--	X	--	MW-1	X	X	--	--	--	--	--	--	Evaluate bedrock groundwater Mike Horse fault contributions to creek	--

NOTES:
Drainage Basin
PM-Paymaster Gulch
PD-Pass Creek Meadow
SG-Stevens Gulch
SW-Swamp Gulch
1. Some samples satisfy multiple investigation objectives.

BR-Blackfoot River
ED-Edith Mine
BC-Beartrap Creek
AN-Anaconda Creek
MH-Mike Horse Creek

Media
GW - Groundwater

-- Not Applicable
Field = specific conductance, pH, temperature, oxidation-reduction potential, dissolved oxygen
Metals=aluminum, arsenic, cadmium, copper, iron, manganese, mercury, zinc
Standard Analyte Suite = Common Cations (calcium, magnesium, potassium, sodium) and Common Anions (carbonate, bicarbonate, sulfate, chloride)

Table A-9 Groundwater Field Parameters			
Parameter	SOP Number(1)	SOP Title	Event
Specific Conductance	SOP-05	Field Measurement of Specific Conductance	All
pH	SOP-06	Field Measurement of pH	All
Temperature	SOP-07	Field Measurement of Water Temperature	All
Oxidation-Reduction Potential	SOP-28	Field Measurement of Redox Potential (Eh)	All
Dissolved Oxygen	SOP-08	Field Measurement of Dissolved Oxygen	All
Depth to Water	SOP-20	Field Measurement of Groundwater Level	All

1 Tetra Tech Standard Operating Procedures (Appendix A-2)

Table A-10 Groundwater Sampling Requirements		
Parameter	Preservation(1)	Bottle Size/Type
Physiochemical	Cool to 4°C	100 milliliter polyethylene
Dissolved Metals	Filtered through 0.45 micron filter; HNO3 to pH < 2; Cool to 4°C	250 milliliter polyethylene
Common Cations	HNO3 to pH < 2; Cool to 4°C	100 milliliter polyethylene
Common Anions	Cool to 4°C	100 milliliter polyethylene

HNO3 = nitric acid

Table A-11 Groundwater Analytical Requirements			
Parameter	PQL (mg/l)(1)	EPA Method No.	Max. Holding Time
Physicochemical			
Specific Conductivity	1.0	120.1 / 2510B	7 days
pH	None	150.1 / 4500-H +B	Upon arrival at lab
Oxidation Reduction Potential	1.0	Field	Field
Dissolved Oxygen	0.1	Field	Field
Turbidity (NTU)	0.01	180.1	48 hours
Hardness as CaCO3	7	2340B	14 days
Acidity	1.0	305.1 / 2310B	14 days
Total Dissolved Solids	10	160.1 / 2540C	7 days
Total Suspended Solids	1	160.2 / 2540C	7 days
Metals(2)			
Aluminum	0.03	200.7	6 months
Arsenic	0.002	200.8	6 months
Cadmium	0.00008	200.8	6 months
Copper	0.001	200.8	6 months
Iron	0.03	200.8	6 months
Lead	0.0005	200.8	6 months
Manganese	0.005	200.7	6 months
Mercury	0.00001	245.1	28 Days
Zinc	0.01	200.7	6 months
Common Cations(2)			
Calcium	1.0	200.7	6 months
Magnesium	1.0	200.7	6 months

Table A-11 Groundwater Analytical Requirements			
Parameter	**PQL (mg/l)(1)**	**EPA Method No.**	**Max. Holding Time**
Potassium	1.0	200.7	6 months
Sodium	1.0	200.7	6 months
Common Anions(2)			
Sulfate	1.0	375.0/4500SO4 E	28 Days
Bicarbonate	None	310.1 / 2320B	14 Days
Carbonate	None	310.1 / 2320B	14 Days
Chloride	1.0	325 / 4500-Cl C	28 Days

1. PQL = Practical Quantitation Limit in milligrams per liter (mg/L) unless otherwise noted
2. Groundwater parameters will be analyzed as dissolved constituents as filtered through a 0.45 micron filter

Table A-12 Soil and Mine Waste Analytical Requirements		
Parameter	**Method(1)**	**PQL(2)**
Saturated Paste pH (s.u.) and Electrical Conductivity (mmhos/cm)	ASAM10-3	--
Total Organic Carbon	STD 501-034	--
Total Aluminum	SW-846 – 6020 / 6010B	1
Total Arsenic (mg/kg)	SW-846 – 6020 / 6010B	0.5
Total Cadmium (mg/kg)	SW-846 – 6020 / 6010B	0.15
Total Copper (mg/kg)	SW-846 – 6020 / 6010B	0.5
Total Iron	SW-846 – 6020 / 6010B	5
Total Lead (mg/kg)	SW-846 – 6020 / 6010B	0.2
Total Manganese (mg/kg)	SW-846 – 6020 / 6010B	10
Total Mercury (mg/kg)	SW-846 – 7471	0.5
Total Zinc (mg/kg)	SW-846 – 6020 / 6010B	2
Acid-Base Accounting & Synthetic Precipitation Leaching Procedure		
Acid-Base Accounting	Modified Sobek	--
Synthetic Precipitation Leaching Procedure	EPA 1312	--

Note: XRF Screening will compare results to most stringent Ecological Risk Soil Screening Levels (EcoSSLs)

1. USDA Handbook 60 - Diagnosis and Improvement of Saline and Alkali Soils (USDA, 1954)
   Sobeck - Field and Laboratory Methods Applicable to Overburdens and Minesoils (EPA, 1978)
   Methods of Soil Analysis - American Society of Agronomy, Parts I and II. Monograph No. 9 (1982)
   SW-846 - Test Methods for Evaluating Solid Waste-Physical Chemical Methods (EPA, 1986)
2. PQL = Practical quantitation limit

Table A-13 Laboratory Methodologies and Detection Limits for UBMC Desired Plant Tissue Metals Analysis		
Metals (total)	**EPA Method**	**PQL (mg/Kg)**
Aluminum	M601B ICP	3.000
Arsenic	M6020 ICP-MS	0.050
Cadmium	SW-846 – 6020 / 6010B	0.010
Copper	SW-846 – 6020 / 6010B	1.000
Iron	SW-846 – 7471	2.000
Lead	SW-846 – 6020 / 6010B	0.010
Manganese	SW-846 – 6020 / 6010B	0.500
Mercury	SW-846 – 6020 / 6010B	0.020

Table A-13 Laboratory Methodologies and Detection Limits for UBMC Desired Plant Tissue Metals Analysis		
Metals (total)	**EPA Method**	**PQL (mg/Kg)**
Silver	SW-846 – 6020 / 6010B	0.005
Zinc	SW-846 – 6020 / 6010B	1.000

Table A-14 Tentative 2008 Season-Specific Investigation Schedule	
Task Description	**Completion Date**
Submit Draft spring 2008 Sampling and Analysis Plan	Oct. 31, 2007
Submit Draft Final spring 2008 Sampling and Analysis Plan	Nov. 30, 2007
Submit Final spring 2008 Sampling and Analysis Plan	Dec. 31, 2007
Submit outline of proposed additional tasks (Task 5)	Feb. 15, 2008
Submit technical memorandum regarding additional tasks (Task 5)	Mar. 7, 2008
Notice to proceed with field activities will occur after incorporation of DEQ comments into the final RI Work Plan (addendum; Task 6)	
Commence with spring 2008 field activities	April 3, 2008

Table A-15 Decision Inputs		
Source Material	**Typical Data Parameters**	**Data Uses**
Surface Water	Laboratory parameters: physiochemical; total and dissolved metals, common cations and common anions Field parameters: flow, pH, temperature, specific conductance, dissolved oxygen	Evaluate data gaps, potential sources of elevated metals (i.e. fault zones, tributaries, mine waste), and potential risk to human health and the environment.
Groundwater	Laboratory parameters: physiochemical; dissolved metals; common cations and common anions Field parameters: specific conductance, pH, temperature, oxidation-reduction, dissolved oxygen, depth to water	Evaluate data gaps, potential sources of elevated metals (i.e. fault zones, groundwater zones, mine waste), and potential risk to human health and the environment.
Sediment	Laboratory parameters: total metals; screen to <63 micron	Evaluate data gaps, sediment with elevated metal concentrations, and sediments of potential risk to human health, ecological receptors, and environment.
Soil and Mine Waste	Laboratory parameters: pH, electrical conductivity, total metals	Evaluate data gaps, soil with elevated metal concentrations, and soils of potential risk to human health, ecological receptors, and environment.

Table A-15 Decision Inputs		
Source Material	**Typical Data Parameters**	**Data Uses**
Aquatics (macroinvertebrates and periphyton)	Analyses: macroinvertebrate species, chlorophyll A, ash, and biointegrity and pollution indices calculated, metals.	Evaluate they type and number of macroinvertebrates and periphyton present in surface water to evaluate water quality impact to ecological receptors.
Vegetation	Laboratory parameters: metals	Evaluate potential effects of mine waste on vegetation and effectiveness of reclamation activities on former mine waste/reclaimed mine waste.
Small Mammals	Laboratory parameters: metals	Evaluate potential effects of mine waste on small mammal receptors.

Table A-16 Decision Rule – Comparison with Applicable Standards and Screening Levels		
Source Material	**Data Parameters**	**Contaminant Concentration Comparison**
Surface Water	Laboratory parameters: sulfate; total and dissolved (aluminum only) metals. Field parameters: flow, pH, temperature, specific conductance	Circular DEQ-7 water quality standards.
Groundwater	Laboratory parameters: sulfate; total (only for domestic wells or domestic well concerns) and dissolved metals;	Circular DEQ-7 water quality standards.
Sediment	Laboratory parameters: total metals; screen to <63 micron; one-half of all samples (primarily from first marsh) acid-base accounting and synthetic precipitation leaching procedure	EPA Region 9 Preliminary Remediation Goals (PRGs), DEQ Remediation Division Action Level for Arsenic in Surface Soil (2005) and Washington State Department of Ecology Freshwater Sediment Quality Values (WA 1997) or Department of Energy Preliminary Remediation Goals for Ecological Endpoints (DOE 1995 and 1997).
Soil and Mine Waste	Laboratory parameters: pH, electrical conductivity, total organic carbon, total metals, one-half of all samples acid-base accounting and synthetic precipitation leaching procedure	EPA Region 9 Soil PRGs and DEQ Remediation Division Action Level for Arsenic in Surface Soil (2005)
Aquatic Organisms (macroinvertebrate s and periphyton)	Analyses: macroinvertebrate species, chlorophyll A, ash, and biointegrity and pollution indices calculated.	Results will be compared to standard indices for community analysis.
Vegetation	Laboratory parameters: metals	Langley, A., et al., 2003
Small Mammals	Laboratory parameters: metals	Note 1

Notes:

1 – Pershagen & Vahter, 1979; Wilson, et al., 1941; Herbert, et al., 1993; Schlicker & Cox, 1968.

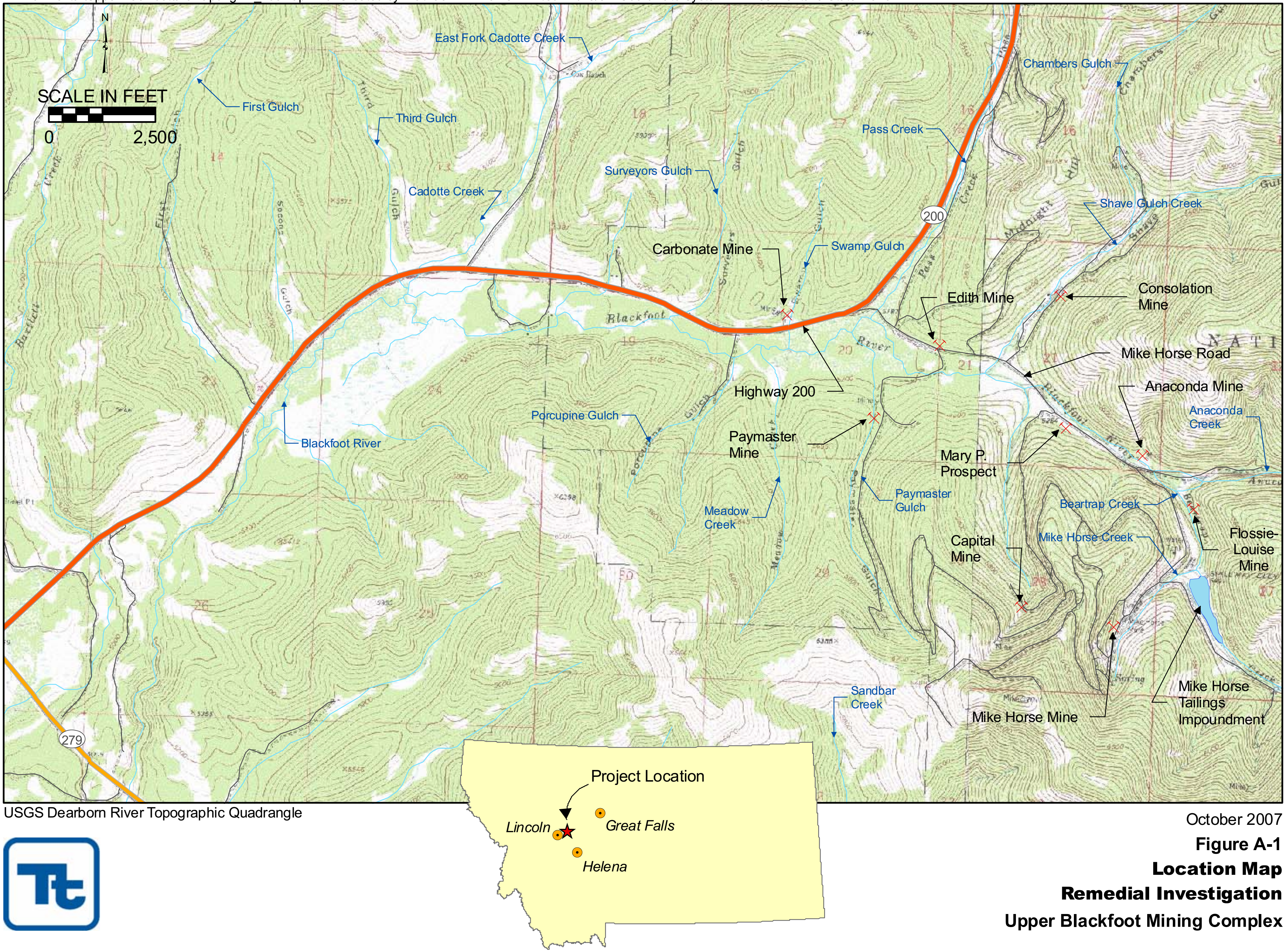
Table A-17 Field QA/QC Sample Objectives			
QC Sample	**Purpose**	**Frequency**	**QA Objective**
Equipment Rinsate Blanks	Quantify artifacts introduced during sampling, decontamination, transport, from ambient air, in decontamination water supply, or analysis of samples – measure of accuracy and representativeness	1 per day per day, not to exceed 1 per 20 samples. If more than 20 samples per day, collect additional samples accordingly.	Target analytes not detected
Field Blank	Quantify artifacts introduced during sampling, transport, from ambient air	1 per day per day, not to exceed 1 per 20 samples. If more than 20 samples per day, collect additional samples accordingly. Equipment rinsate blanks can be collected in lieu of field blanks.	Target analytes not detected.
Blind Field Standard	Measure analytical accuracy and precision.	1 per media per sampling event	Target analytes detected with manufacturer-specified limits.

Table A-18 Precision, Accuracy, and Completeness Requirements				
Precision		**Accuracy**		**Completeness**
Solid	**Water**	**Solid**	**Water**	
Manufacturer Specified for Blind Field Standards		75%-125%, or method specified	75%-125%, or method specified	90%

Table A-19 Result and Data Qualifiers	
Qualifier	**Description**
<	The analyte was analyzed for but not detected at the practical quantitation limit used for the method.
H	The required holding time was exceeded.
F%	Field duplicate analysis exceeded acceptable limits – relative % difference determination
F	Field duplicate results exceed acceptable limits - PQL determination
M%	Matrix spike recoveries exceed acceptable limits.
B	Method blank shows evidence of contamination
U	The material was analyzed for, but was not detected above the level of the associated value. The associated value is the practical quantitation limit (PQL).
J	The associated value is an estimated quantity
R	The data are unusable

FIGURES

Environmental\UpperBlackfoot\arcmap\Fig1-1_LocMap.mxd Created by: Patricia A. Williams Printed: 11/29/07 Coordinate System: NAD83 Montana State Plane



USGS Dearborn River Topographic Quadrangle

October 2007

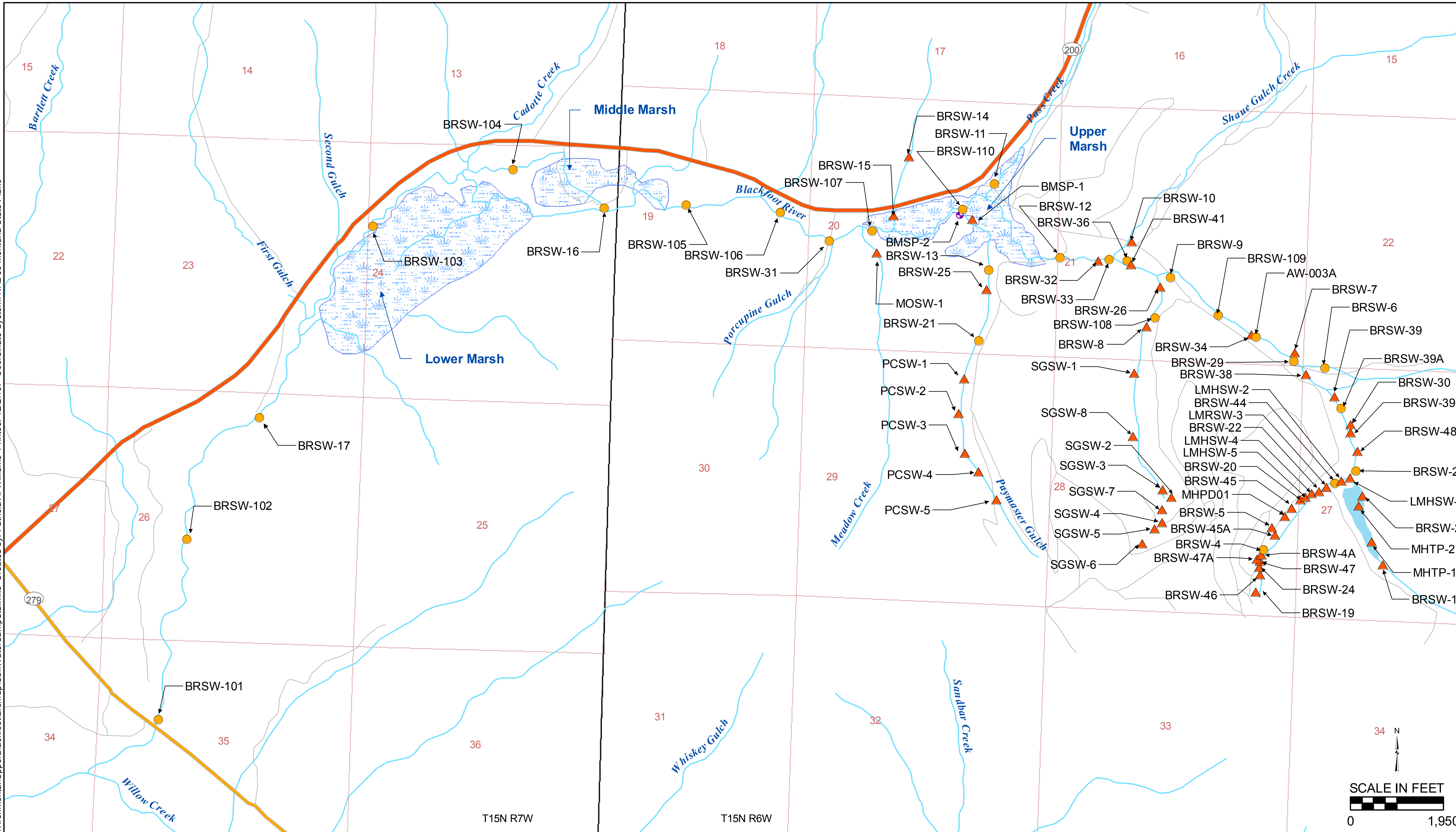
Figure A-1

Location Map

Remedial Investigation

Upper Blackfoot Mining Complex

Environmental\UpperBlackfoot\arcmap\SurfWaterSampSta.mxd Created by: Patricia A. Williams Printed: 12/27/07 Coordinate System: NAD83 Montana State Plane



Historic Surface Water Sampling Locations	Highway	Streams
2007 Surface Water Sampling Locations	Major Road	Mike Horse Tailings Impoundment
Flowing Well Proposed Sample (abandoned)	Local Road	Marshes

December 2007

Figure A-2

Surface Water Sampling Stations

Remedial Investigation

Upper Blackfoot Mining Complex

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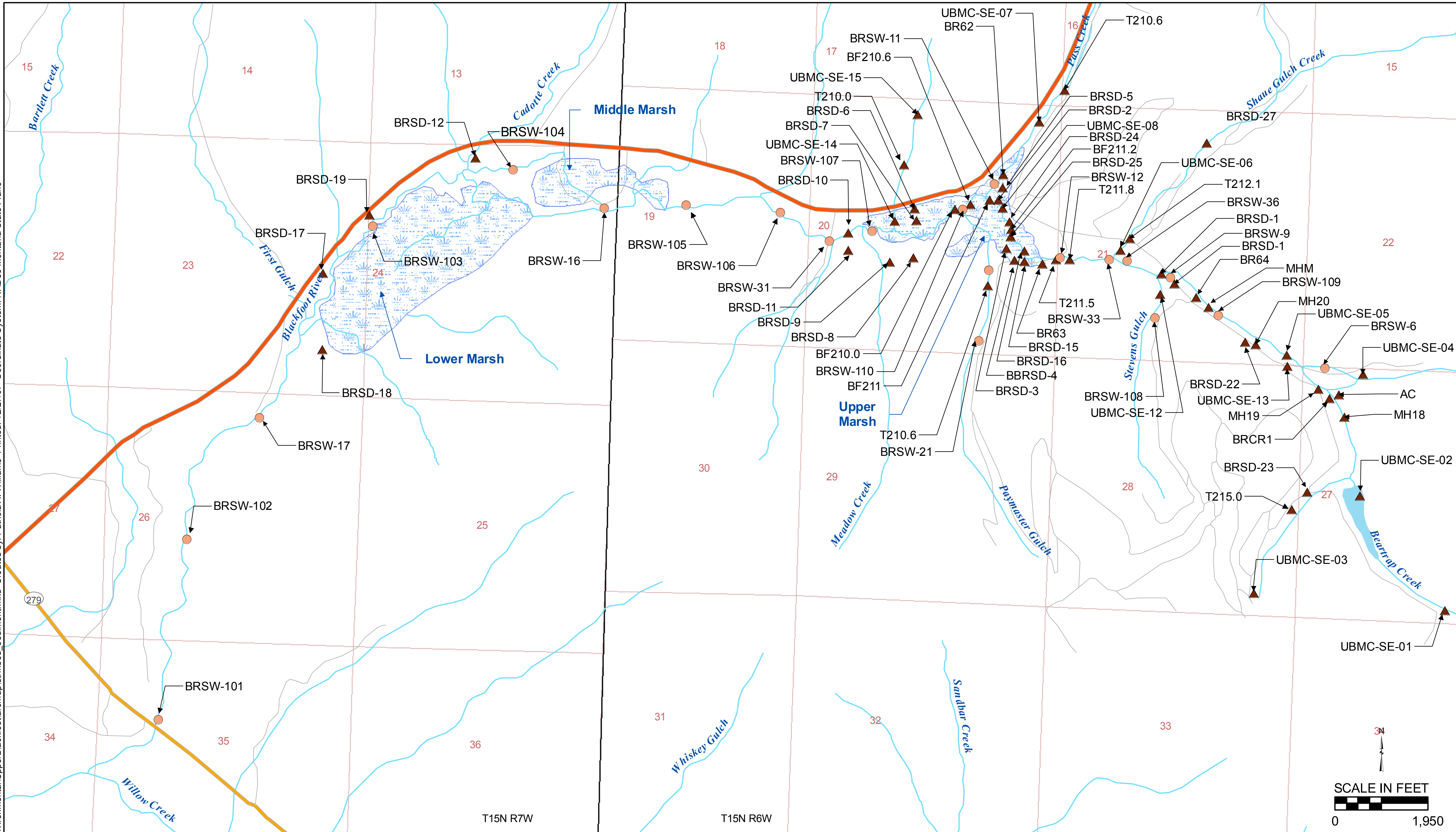


December 2007

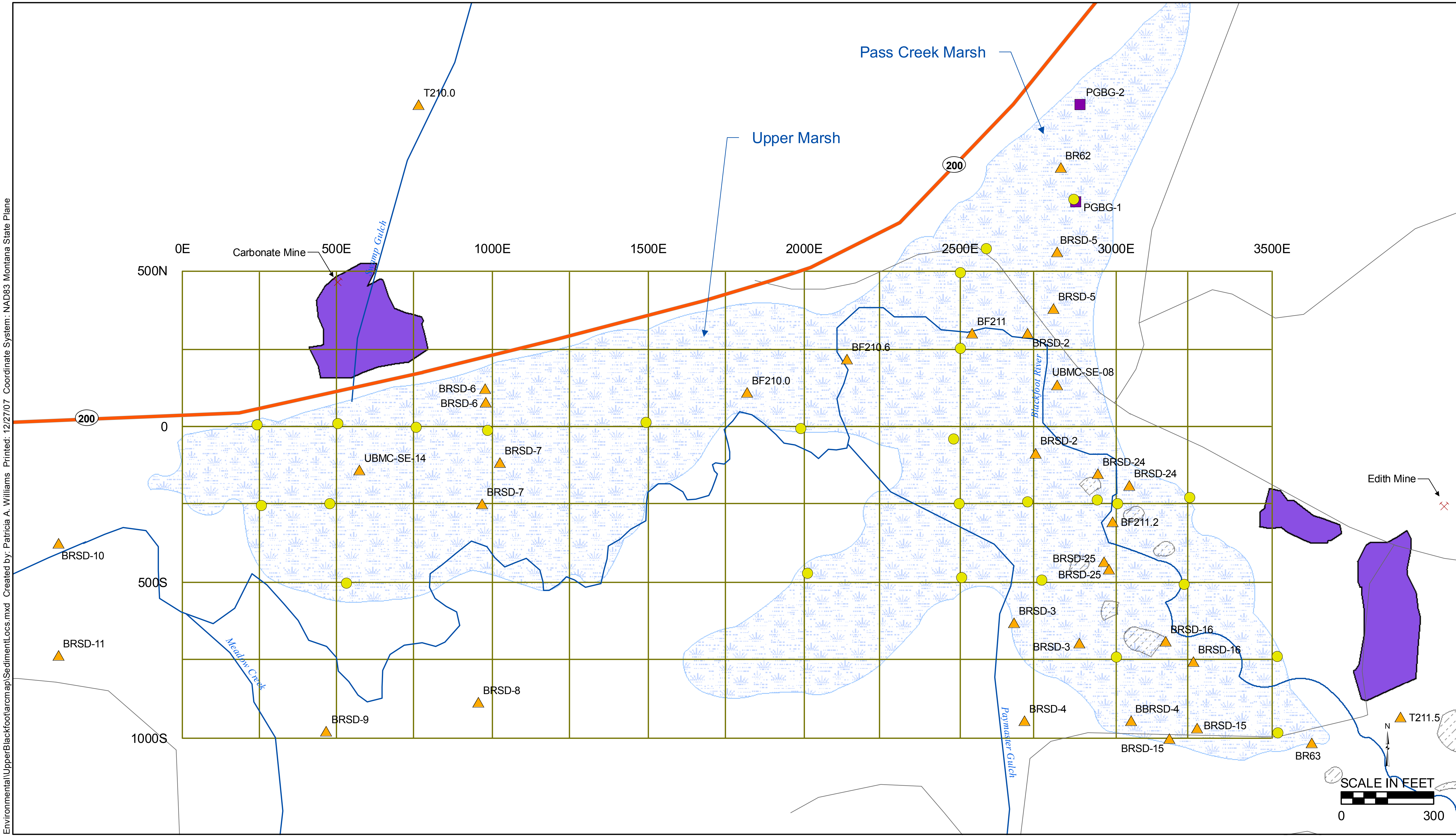
Figure A-3

Streambed Sediment Sampling Stations

Remedial Investigation

Upper Blackfoot Mining Complex

- 2007 Streambed Sediment Sampling Location
- Historic Sediment Sample Locations
- Highway
- Major Road
- Local Road
- Streams
- Mike Horse Tailings Impoundment
- Marshes



Mines
2007 Upper Marsh Sediment Sample Location
2007 Background Sediment Sample Location
Historic Sediment Sample Location
Grid Lines
Mine Waste Removal/Reclaimed Areas (sampled in 2007)
Area of Dispersed Sandy (Fine) Tailings
Area of Concentrated Tailings/Mine Waste
Area of Dispersed Coarse-Grained Tailings
Anaconda Wetland Treatment Cells
Local Roads
State Highway
Streams
Marshes

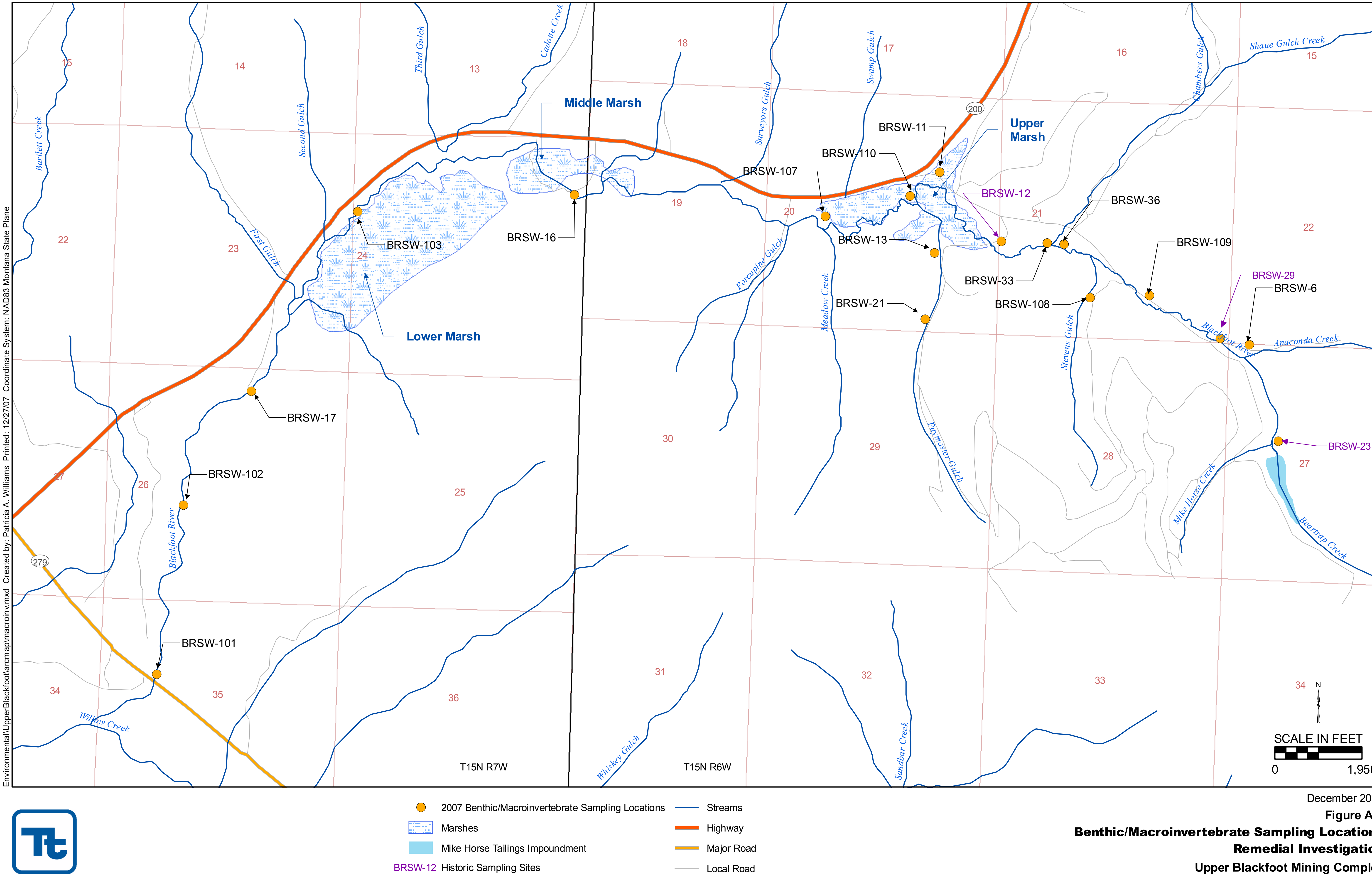
December 2007

Figure A-4

Upper Marsh Sediment Sampling Locations

Remedial Investigation

Upper Blackfoot Mining Complex



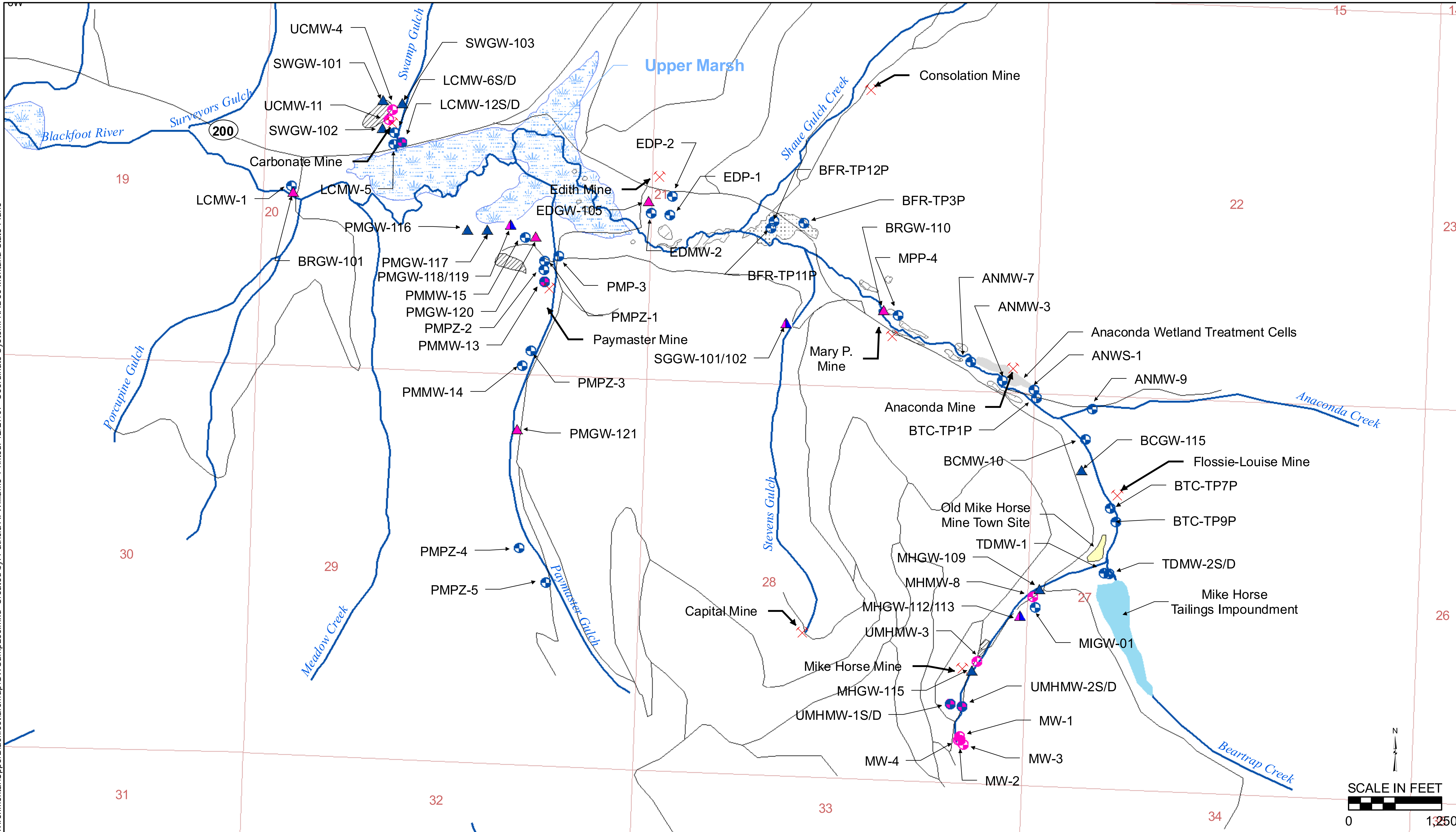
December 2007

Figure A-5

Benthic/Macroinvertebrate Sampling Locations

Remedial Investigation

Upper Blackfoot Mining Complex



Environmental\UpperBlackfoot\arcmap\GWSampLoc.mxd Created by: Patricia A. Williams Printed: 12/27/07 Coordinate System: NAD83 Montana State Plane

- mines
- 2007 Groundwater Sample Location - Alluvial/Bedrock Pair
- 2007 Groundwater Sample Location - Alluvial
- 2007 Groundwater Sample Location - Bedrock
- Existing Groundwater Sample Location - Alluvial/Bedrock Pair
- Existing Groundwater Sample Location - Alluvial
- Existing Groundwater Sample Location - Bedrock
- Old Mike Horse Mine Town Site
- Roads
- Streams
- Marshes
- Mike Horse Tailings Impoundment

December 2007

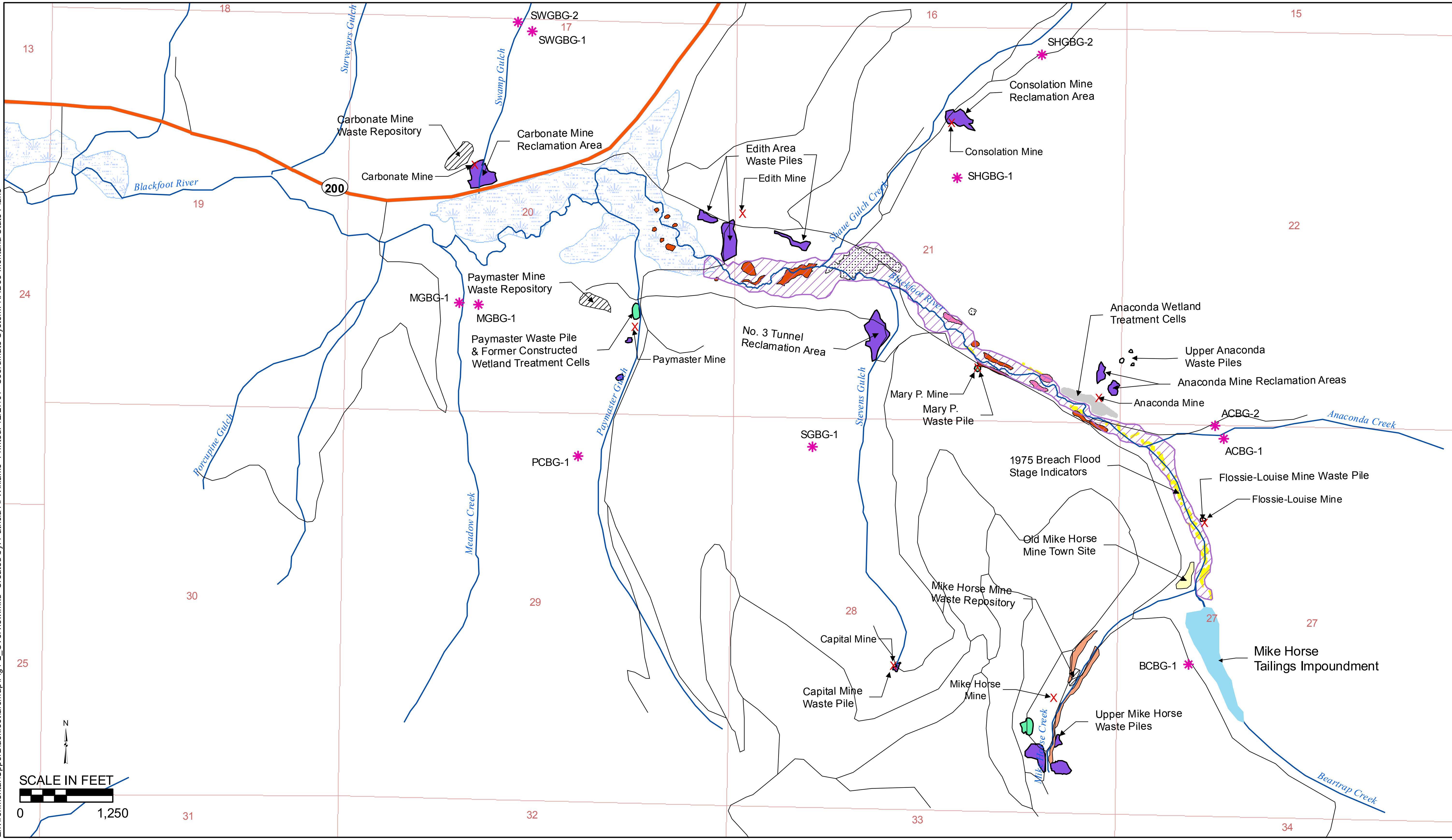
Figure A-6

Groundwater Sampling Locations

Remedial Investigation

Upper Blackfoot Mining Complex

Environmental\UpperBlackfoot\arcmap\Fig1-2_Overview.mxd Created by: Patricia A. Williams Printed: 12/27/07 Coordinate System: NAD83 Montana State Plane



Background Soil Samples	Estimated Edge of Streamside Impacts Soil Sampling	Area of Dispersed Sandy (Fine) Tailings	1975 Breach Flood Stage Indicator
Mines	Evaluation of Potential Mike Horse Mining Impacts	Area of Concentrated Tailings/Mine Waste	Mine Waste Repository
Streams	Mine Waste Removal Areas (not sampled in 2007)	Area of Dispersed Coarse-Grained Tailings	Old Mike Horse Mine Town Site
Marshes	Mine Waste Removal/Reclaimed Areas (sampled in 2007)	Anaconda Wetland Treatment Cells	Mike Horse Tailings Impoundment
	Unreclaimed Mine Waste Areas (sampled in 2007)		

December 2007

Figure A-7

Overview of Mine Waste Areas

Remedial Investigation

Upper Blackfoot Mining Complex

APPENDIX A-1
HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN (HASP)

UBMC - Remedial Investigation AT Mike Horse Creek Road, Montana

Prepared By:	Natalie Morrow Missoula Montana	**Date:** **Tt Project No:**	November 30, 2007 115 7561589

Project Identification:

Service Type:	Environmental Sciences	**Site Name:**	Upper Blackfoot Mining Complex
Client Name:	DEQ	**Site Location:**	~15 miles east of Lincoln, MT
Client Contact:	David Bowers-Project Mgr	**Client Phone No:**	(406) 841-5063

Site History: The Upper Blackfoot Mining Complex is an area with several mine sites, Mike Horse Mine being the largest of the mines. Mining related wastes within and downstream of the UBMC includes former and existing tailing and waste rock piles, and metals-impacted sediments from mining activities, and breech of the Mike Horse tailings impoundment on Beartrap Creek. Asarco and Arco completed several reclamation activities in the 1990's including mine waste removals, installation settling ponds and constructed wetlands to treat discharges from the Mike Horse and Anaconda adits. Investigations to characterize wastes at the facility has included sampling mine waste, soil, sediment, surface water and groundwater. Contaminants of concern for the facility include heavy metals and metalloids, including arsenic, cadmium, copper, lead, and zinc, and potentially others. Data gaps remain for the facility following the previous investigations.

Scope of Work: Tetra Tech has been contracted by DEQ to perform a remedial investigation to fill data gaps remaining after previous investigation. The investigation will include installation and sampling of bedrock wells and groundwater sampling of existing wells; surface water and sediment sampling, soil sampling, and mine waste sampling.

Site Regulatory Status:

CERCLA/SARA		RCRA		OSHA		OTHER FEDERAL	
US EPA:	N	**US EPA:**	N	**1910:**	Y	**DOE:**	N
State:	Y	**state:**	Y	**1926:**	N	**USATHAMA:**	N
NPL site:	N	**NRC**		**state:**	Y	**Air Force:**	N
		10CFR20:	N				

Review and Approval Documentation

Reviewed By:

Name: ______________________ Initial ________

Title: ______________________ Date: ________

Reviewed By:

Name: ______________________ Initial ________

Title: ______________________ Date: ________

Reviewer signature also certifies that the PPE selected for this project was based on a hazard assessment and selected according to the requirements established by OSHA in 29 CFR 1910.132 (d).

HEALTH AND SAFETY PLAN (HASP)

UBMC - Remedial Investigation AT Mike Horse Creek Road, Montana

Project Dates		Amendment Dates:	
Project Start Date:	To be determined	1	
Project End Date:	July 31, 2008	2	
This site HASP must be reissued/reapproved for		3	
activities conducted after:	July 31, 2007	4	

Tetra Tech Representatives

Branch Address and Phone		Name/Title	Role and Responsibilities
Tetra Tech	406-582-8780	Allan Kirk	Project Manager
303 Irene Street		Jim Maus	Field Task Leader
Helena, MT 59604		Randy English	Field Sampling Team
Tetra Tech	406-543-3045	Natalie Morrow	Asst PM / Field Site Supervisor
2436 Dixon Avenue		Danny Earnest	Field Task Leader
Missoula, MT 59801		Don May	Field Sampling Team
		Thad Jones	Field Sampling Team
		Stacy Pease	Field Sampling Team
		Liz Fagan	Field Sampling Team
Tetra Tech	406-453-1641	Scott Vosen	Field Sampling Team
1601 2nd Avenue N., Suite 116		Nate Shumate	Field Sampling Team
Great Falls, MT			
Tetra Tech	(406) 582-8780	Shane Matolyak	Field Sampling Team
851 Bridger Drive, Suite 6		Katie Schultz	Field Sampling Team
Bozeman, MT			

Tetra Tech Subcontractors

Organization/Address and Phone		Name/Title	Role and Responsibilities
Boland Drilling	406-761-1063	Chris Boland	Owner/Manager
Great Falls, MT			
	Scope of Work	Drill and install 20 bedrock wells up to 200 feet deep at the facility.	

Organization/Address and Phone		Name/Title	Role and Responsibilities
Boland Drilling	406-761-1063	Chris Boland	Owner/Manager
	Scope of Work	Excavate test pits in mine tailings and waste rock to a depth at which native soil is encountered or up to the excavation limits of the excavation equipment.	

HEALTH AND SAFETY PLAN (HASP)

UBMC - Remedial Investigation AT Mike Horse Creek Road, Montana

Organization/Address and Phone	Name/Title	Role and Responsibilities
Morrison Mairle 406-442-3050 Helena, MT	Gunner Getchell	Project Manager
Scope of Work	Survey soil sampling locations prior to commencement of sampling activities.	

Client / Tetra Tech / Subcontractor H&S Program & Policy Bridging Section

Identify which specific H&S programs will be followed for the designated scope of work.

H&S Program	Specify Program To Be Used	Comments
Emergency Evacuation Procedures	☐ Client X Tetra Tech ☐ Sub ☐ Other	All site personnel will follow the evacuation procedures detailed by the client for this products terminal
Drilling and subsurface structure locates	☐ Client X Tetra Tech ☐ Sub ☐ Other	The ERD Safety Guidance Document will be utilized for identifying potential subsurface structures prior to drilling

Tetra Tech's policy is to provide a safe working environment for all employees and contractors so that work may be conducted in a safe and efficient manner.

Tetra Tech employees and subcontractor employees working at the specific project covered by this HASP shall adopt and adhere to this HASP and the above referenced programs/policies by following all requirements stated in the safe work practices applicable to their work. No work is so urgent or important that we cannot take the time to do it safely. **ALL** personnel on site including subcontractor's have the right and responsibility to stop the work if they feel a safety protocol is not being followed or if they feel an unsafe condition exists.

Site Specific Health and Safety Personnel

Natalie Morrow has been designated **Site Health and Safety Coordinator (SHSC)** for activities to be conducted at this site. The SHSC has total responsibility for ensuring that the provisions of this HASP are adequate and implemented in the field. Changing field conditions may require decisions to be made concerning adequate protection programs. Therefore, the personnel assigned as SHSCs are experienced and meet the additional training requirements specified by OSHA in 29 CFR 1910.120.

Danny Earnest, Jim Maus, Don May, Thad Jones, Shane Matolyak have been designated as **alternate SHSC(s)**.

Activities Covered Under This Plan

Task 1	**Schedule:**	Start date Oct. 3, 2007
Monitoring well installation & sampling	Drill and install bedrock monitoring wells using an air-rotary drill rig.	
Task 2	**Schedule:**	Start date Oct. 3, 2007
Surface water, sediment sampling, aquatic organism sampling	Collect surface water, sediment, and aquatic organism samples along Mike Horse, Beartrap, Anaconda, and Paymaster creeks, Blackfoot River, and Blackfoot River within the Upper, Middle, and Lower marshes.	

HEALTH AND SAFETY PLAN (HASP)

UBMC - Remedial Investigation AT Mike Horse Creek Road, Montana

Task 3	**Schedule:**	Start date Oct. 3, 2007
Soil sampling	Collect soil samples within the Upper Marsh along the Blackfoot River.	
Task 4	**Schedule:**	Start date Oct. 3, 2007
Mine waste sampling	Collect mine waste samples from tailings and waste rock piles at the facility.	
Task 5	**Schedule:**	Start date Oct. 3, 2007
Ecological sampling	Collect ecological samples (vegetation, aquatics, small mammals) at the facility.	

Types and Sources of Hazards

Physiochemical		Radiation		Chemically Toxic	
Flammable:	N	**Ionizing:**	External	**Inhalation:**	Y
Explosive:	N	**Non-Ionizing:**	UV-sun	**Ingestion:**	Y
Corrosive:	Y	**Other**		**Absorption:**	Y
Reactive:	N	**Physical Hazards:**	Y	**Carcinogen:**	Y
O2 Rich:	N	**Construction Activities:**	Y	**Mutagen:**	Y
O2 Deficient:	N			**Teratogen:**	Y
Biological				**OSHA listed:**	Y
Etiological Agent:	y/n	**Specific OSHA Standards:**	1910.120 general; 1926.62 - lead; 1910.1018 arsenic		
Other:	y/n				
(plant, insect, animal)	Y				

Direct Sources of Hazards				Indirect Sources (Describe)
Air:	Y	**Other:**	Y mine wastes	None other than those listed
Groundwater:	Y			
Soil:	Y			
Surface Water:	Y			

Health and Safety Evaluation - Chemicals of Concern

Chemical Name	Entry Route	Carc*	Symptoms	Target Organs
Aluminum (metal or powder)	Inh, Ing, Con	n	Eyes, skin and respiratory tract irritant.	Eyes, skin, respiratory tract.

Arsenic (inorganic compounds as As)	Inh, Abs, Ing, Con	y	Ulceration of nasal septum, dermatitis, GI disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin, cancer.	Liver, kidneys, skin, lungs, lymphatic system (lung and lymphatic cancer).
Cadmium (dust and fumes)	Inh, Ing (dust)	y	Pulmonary edema, dyspnea, cough, tight chest, substernal pain, headache, chills, muscle aches, nausea, vomiting, diarrhea, loss of smell, emphysema, proteinuria, mild anemia, cancer.	Respiratory system, kidneys, prostate, blood (prostate and lung cancer).
Chromium (Chromic acid and chromates as Cr(VI))	Inh, Ing, Con	y	Respiratory system irritation, nasal septum perforation, liver and kidney damage, leukocytosis, leukopenia, monocytosis, eosinophilia, eye injury, conjunctivitis, skin ulceration, sensitization dermatitis, cancer.	Blood, respiratory system, liver, kidneys, eyes, skin (lung cancer).
Chromium (metal & compounds as Cr(III))	Inh, Ing, Con	n	Eye irritation, sensitization dermatitis.	Eyes, skin.
Copper (dusts, mists, and fumes)	Inh, Ing, Con	n	**Dusts and mists** - Irritant (eyes, nose, pharynx), nasal perforation, metallic taste, dermatitis. **Fume**-Irritant (eyes, upper respiratory system), metal fume fever, chills, muscle ache, nausea, fever, cough, exhaustion, metallic/sweet taste, discoloration	Eyes, skin, respiratory system, liver kidneys. (Increased risk of Wilson's disease)
Iron Oxide (dust and fumes)	Inh	n	Benign pneumoconiosis with X-ray shadows indistinguishable from fibrotic pneumoconiosis (siderosis).	Respiratory System.
Lead (elemental and other compounds as Pb)	Inh, Ing, Con	n	Weakness, exhaustion, insomnia, facial pallor, anorexia, weight loss, malnutrition, constipation, abdominal pain, colic, anemia, tremor, wrist and ankle paralysis, encephalopathy, kidney disease, eye irritation, hypotension.	Eyes, GI tract, central nervous system, kidneys, blood, gingival tissue.
Manganese (metal, compounds, and fume)	Inh, Ing	n	Parkinson's, asthenia,insomnia, mental confusion, metal fume fever: dry throat, cough, chest tightness, dypsnea, rales, flu-like fever; low-back pain, vomiting, malaise, fatigue, and kidney damage.	Respiratory system, central nervous system, blood, and kidneys.
Mercury (elemental and inorganic compounds as Hg)	Inh, Abs, Ing, Con	n	Irritant (eyes, skin), cough, chest pain, dyspnea, bronchial pneumonitis, tremor, insomnia, irritability, indecision, headache, fatigue, weakness, stomatitis, salivation, proteinuria, GI disturbance, anorexia, weight loss.	Eyes, skin, respiratory system, central nervous system, kidneys.
Silver (metal and soluble compounds as Ag))	Inh, Ing, Con	n	Blue-gray eyes, Irritant (eyes, skin, nasal septum, throat), skin ulceration, GI disturbance.	Nasal septum, skin, eyes.
Zinc Oxide (dust and fume)	Inh	n	Metal fume fever, chills, muscle ache, nausea, fever, dry throat, cough, weak, exhaustion, metallic taste, headache, blurred vision, low back pain, vomiting, fatigue, tight chest, dyspnea, decreased pulmonary function.	Respiratory system.

Health and Safety Evaluation - Hazard Evaluation of Chemicals of Concern

Chemical Name	LEL/UEL (%)	Flam	OT (ppm)	IDLH	Exposure Limits
Arsenic (inorganic compounds as As)	NA	n	-	Not Determined	**OSHA-PEL-TWA** = 15 mg/m3 (total); 5 mg/m3 (respirable); **ACGIH-TLV-TWA** = 10 mg/m3 (total) NIOSH-**REL-TWA** = 10 mg/m3 (total); 5 mg/m3 (respirable);
Aluminum (metal or powder)					
Cadmium (dust and fumes)	NA	n	-	(Cr(III) 25 (metal) 250 mg/m3	**OSHA-PEL-TWA** = 1 mg/m3 (metal); 0.5 mg/m3 (CrIII); **ACGIH-TLV-TWA** = 0.5 mg/m3; **NIOSH-REL-TWA** = 0.5 mg/m3
Copper (dusts, mists, and fumes)	NA	n	-	100 mg/m3	**OSHA-PEL-TWA** = 1 mg/m3 (dusts & mists); 0.1 mg/m3 (fume); **ACGIH-TLV-TWA** = 1 mg/m3 (dusts & mists); 0.2 mg/m3 (fume) **NIOSH-REL-TWA** = 1 mg/m3 (dusts & mists); 0.1 mg/m3 (fume)
Iron Oxide (dust and fumes)	NA	n	-	2500 mg/m3	**OSHA-PEL-TWA** = 10 mg/m3; **ACGIH-TLV-TWA** = 5 mg/m3 (respirable); **NIOSH-REL-TWA =** 5 mg/m3
Lead (elemental and other compounds as Pb)	NA	n	-	500 mg/m3	**OSHA-PEL-TWA** = 5 mg/m3; **ACGIH-TLV-TWA** = 0.2 mg/m3; **NIOSH-REL-TWA** = 1 mg/m3; **NIOSH -REL-STEL** = 3 mg/m3
Mercury (elemental and inorganic compounds as Hg)	NA	n	-	10 mg/m3	**OSHA-PEL-TWA** = 0.1 mg/m3; **ACGIH-TLV-TWA** = 0.025 mg/m3; **NIOSH-REL-TWA** = 0.05 mg/m3 (skin); **NIOSH-REL-Ceiling** = 0.1 mg/m3 (skin)
Silver (metal and soluble compounds as Ag))	NA	n	-	10 mg/m3	**OSHA-PEL-TWA** = 0.01 mg/m3; **ACGIH-TLV-TWA** = 0.1 mg/m3 (metal); 0.01 mg/m3 (soluble compounds as Ag); **NIOSH-REL-TWA** = 0.01 mg/m3
Zinc Oxide (dust and fume)	NA	n	-	500 mg/m3	**OSHA-PEL-TWA** = 5 mg/m3 (fume/respirable dust)*; 15 mg/m3 (total dust)*; **ACGIH-TLV-TWA** = 2 mg/m3 respirable; **ACGIH-TLV-STEL** = 10 mg/m3 respirable **NIOSH-REL-TWA** = 5 mg/m3 (dust and fume); NIOSH-REL-STEL = 10 mg/m3 (fume) **NIOSH-REL-Ceiling** = 15 mg/m3 (dust) *The OSHA limit of TWA = 5 mg/m3 (fume); STEL = 10 mg/m3 (fume); TWA = 10 mg/m3 (total dust); TWA = 5 mg/m3 (resp dust) was vacated by the court ruling of 1993.

Health and Safety Evaluation - Chemicals of Concern / Precautions

PRECAUTIONS

INGESTION: All listed chemicals have the potential for accidental ingestion, however in work place settings it is not considered a primary route of entry. All accidental ingestions should be addressed by referring to the MSDS and seeking immediate medical attention.

INHALATION: Listed chemicals capable of inhalation routes of entry should be maintained below the established exposure limits. If there is indication that the exposure limits are being exceeded, appropriate respiratory protection should be used. If appropriate PPE has not been planned for, work should cease and the SHSC should be contacted.

ABSORBANCE/CONTACT: Listed chemicals presenting an absorbance or contact hazards should be handled only with the use of appropriate PPE.

NOTE: Overexposure to any chemical via any route of entry should be addressed by referring to the MSDS and seeking immediate medical attention. Avoid contact with all chemical hazards when possible and consult MSDS before any exposure may occur.

OTHER PRECAUTIONS

Workers will stand up-wind while drilling and excavating to limit exposure to dust. Drillers may need to add minimal amounts of water while drilling to keep dust controlled. During excavating, workers will limit vehicle and excavator traffic as much as possible to keep dust down. Workers will stand up wind. If dusty conditions, workers will don air-purifying respirators.

ABBREVIATIONS

LEL= Lower Explosive Limit

UEL = Upper Explosive Limit

ppm = parts per million

mg/m3 = milligram per cubic meter

TWA = Time Weighted Average

STEL = Short Term Exposure Limit

Flam = Flammable

IDLH = Immediately Dangerous to Life and Health

OT = Odor Threshold

NOTE: Odor Thresholds were obtained from the American Industrial Hygiene Association's (AIHA) publication on Odor Thresholds. The listed thresholds are best estimates based on existing experimental data. (d) indicates the threshold for detection and (r) indicates the threshold for recognition.

NOTE: * In 1989, OSHA published new exposure limits (in most cases lower) for some chemical compounds. However, in 1993, under a court decision, these newly established limits were vacated and reverted back to the previous limit or to none if a limit was not previously established for the chemical compound. The limits listed in the table are the older, enforceable OSHA limits. It is recommended that the most conservative exposure limit listed be used in assessing exposures and determining controls and safety measures.

Health and Safety Evaluation - Physical / Construction Hazards of Concern

For the hazards that apply to this site, indicate the task(s) to which each particular hazard applies. For the hazards that do not apply to this site, delete the "1" in the Task No(s) column.

HAZARD	Task No(s)	Protection Procedure
Noise	1, 4	Hearing protection should be worn if potential of >85 dB
Heat - Ambient Air	1, 2, 3, 4, 5	Frequent intake of fluids; rest if temp > 100 degrees F
Cold	1, 2, 3, 4, 5	Warm clothing; if symptoms develop - go to warm area
Rain	1, 2, 3, 4, 5	Wear rain gear; watch footing on wet surfaces
Snow	1, 2, 3, 4, 5	Warm clothing - watch footing on slippery surfaces
Electrical Storms	1, 2, 3, 4, 5	Discontinue operations
Heavy Lifting / Moving	1, 2, 3, 4	Utilize proper lifting techniques
Rough Terrain	1, 2, 3, 4, 5	Watch footing
Housekeeping	1, 2, 3, 4, 5	Maintain order
Remote Area	1, 2, 3, 4, 5	Buddy system; comply with contingency / ER plans
Diving	1, 2, 3, 4, 5	Only by certified divers; inspect equipment
Working Over Water	1, 2, 3, 4, 5	Have flotation devices and rescue equipment available
Traffic	1, 2, 3, 4, 5	Obey all traffic regulations; maintain awareness
Heavy Equipment Operation	1, 4	Only qualified operators; inspections and back-up alarms
Lifting Equipment Operation	1	Only licensed operators; equipment inspections required
Working At High Elevations	1, 2, 3, 4, 5	Utilize appropriate fall protection
Excavating / Trenching	1, 4	See Tt H&S Manual; Comply with OSHA regulations
Materials Handling	2, 3	Follow use and storage instructions; consult MSDS
Hazardous Materials Use / Storage	1, 2, 3, 4	Consult MSDS and Tt H&S Manual
Corrosives	1, 2	Consult MSDS and Tt H&S Manual
Utilities - Underground	1, 4	Have located before any work commences
Utilities - Overhead	1, 4	Keep objects more than 20 feet from power lines
Electrical - General	1, 4	See Tt H&S Manual; Comply with OSHA regulations
Electrical - High Voltage	1, 4	See Tt H&S Manual; Comply with OSHA regulations
Hand Tools	2, 3, 4, 5	Use appropriate tools for the task
Other:		
Other:		
Other:		

Task Based Risk Analysis and Protection Plan

The preceding tables have identified the known and suspected hazards to be present in performing the tasks required to complete this project. Below is a breakdown by task of the hazards, likelihood of exposures, and protective protocols to be used to minimize risk.

Task: 1	Monitoring well installation & sampling	
Associated Hazards:	**CHEMICAL**	Acid for preservation of groundwater samples, heavy metals from mine wastes, and/or bedrock encountered during drilling, heavy metals in groundwater.
	PHYSICAL	Drill rig, steep terrain, inclement weather, slip, trip, fall, loud noises. Mine adits and shafts.
	BIOLOGICAL	Mosquitos and other insects, wild animals.
	OTHER	None.

Exposure Potential:	**CHEMICAL**	Very likely
	PHYSICAL	Very likely
	BIOLOGICAL	Likely
	OTHER	not applicble
PPE:	Level D	Steel toe boots, long pants, leather glove, chemical protective gloves, and hard hat and hearing protection during while drill is operating.
Air Monitoring Plan	Field personnel will stand up-wind of the drilling operation when dust is present, driller may add water to boring to suppress dust. Don air-purifying respirator if dust is consistent.	
Air Monitoring Equipment	Don air-purifying respirator if dusty conditions during sampling or during windy condtions.	
Precautions:	**CHEMICAL**	Use chemical resistant gloves when working with groundwater and acid preservatives.
	PHYSICAL	Be aware of surroundings when working and walking around job site, don hearing protection when drill rig is operating.
	BIOLOGICAL	Be aware of surroundings, apply insect repelent as needed.
	OTHER	none

Task Based Risk Analysis and Protection Plan

The preceding tables have identified the known and suspected hazards to be present in performing the tasks required to complete this project. Below is a breakdown by task of the hazards, likelihood of exposures, and protective protocols to be used to minimize risk.

Task:	**2**	**Surface water, sediment sampling, aquatic organism sampling**
Associated Hazards:	**CHEMICAL**	Heavy metals in water and sediment, and acid preservatives for water samples.
	PHYSICAL	Steep and uneven terrain, slip, trip, falls, highway and road traffic in some sampling locations, water, inclement weather. Mine adits and shafts.
	BIOLOGICAL	Insects, wild animals.
	OTHER	None

Exposure Potential:	**CHEMICAL**	Very likely
	PHYSICAL	Very likely
	BIOLOGICAL	Likely
	OTHER	none
PPE:	Level D	Don waterproof waders when working in the marshes and other areas where wading is required, don steel toed boots in other areas of facility when not wearing waders. Wear chemical resistant gloves when sampling and handling acid.
Air Monitoring Plan	No air monitoring.	
Air Monitoring Equipment	Not applicable.	
Precautions:	**CHEMICAL**	Use chemical resistant gloves when working with surface water and sediment and acid preservatives.
	PHYSICAL	Be aware of surroundings when working and walking around job site.
	BIOLOGICAL	Be aware of surroundings, apply insect repelent as needed.
	OTHER	none

Task Based Risk Analysis and Protection Plan

The preceding tables have identified the known and suspected hazards to be present in performing the tasks required to complete this project. Below is a breakdown by task of the hazards, likelihood of exposures, and protective protocols to be used to minimize risk.

Task: 3	**Soil sampling**	
Associated Hazards:	**CHEMICAL**	Heavy metals in soil and dust.
	PHYSICAL	Steep terrain, slip, trip, fall, open excavations, excavation equipment, inclement weather. Mine adits and shafts.
	BIOLOGICAL	Insects and wild animals.
	OTHER	None

Exposure Potential:	**CHEMICAL**	Very likely
	PHYSICAL	Very Likely
	BIOLOGICAL	Likely
	OTHER	None
PPE:	Level D	Steel toed boots, hard hat and hearing protection when working around excavator, chemical resistant gloves.
Air Monitoring Plan	Soil samples will be collected by hand in dry and saturated soil. Personnel will keep vehicle traffic to a minimum when using vehicles in area of sampling, and will sample dry soil such that minimal dust is generated.	
Air Monitoring Equipment	Don air-purifying respirator if dusty conditions during sampling or during windy condtions.	
Precautions:	**CHEMICAL**	Use chemical resistant gloves when working with soil.
	PHYSICAL	Be aware of surroundings when working and walking around job site.
	BIOLOGICAL	Be aware of surroundings, apply insect repelent as needed.
	OTHER	none

Task Based Risk Analysis and Protection Plan

The preceding tables have identified the known and suspected hazards to be present in performing the tasks required to complete this project. Below is a breakdown by task of the hazards, likelihood of exposures, and protective protocols to be used to minimize risk.

Task: 4 Mine waste sampling

Associated Hazards:	**CHEMICAL**	Heavy metals in soil and dust.
	PHYSICAL	Steep terrain, slip, trip, fall, open excavations, excavation equipment, inclement weather. Mine adits and shafts.
	BIOLOGICAL	Insects and wild animals.
	OTHER	None

Exposure Potential:	**CHEMICAL**	Very likely
	PHYSICAL	Very Likely
	BIOLOGICAL	Likely
	OTHER	None
PPE:	Level D	Steel toed boots, hard hat and hearing protection when working around excavator, chemical resistant gloves.
Air Monitoring Plan	Soil samples will be collected by hand in dry and saturated soil. Personnel will keep vehicle traffic to a minimum when using vehicles in area of sampling, and will sample dry soil such that minimal dust is generated.	
Air Monitoring Equipment	Don air-purifying respirator if dusty conditions during sampling or during windy condtions.	
Precautions:	**CHEMICAL**	Use chemical resistant gloves when working with soil.
	PHYSICAL	Be aware of surroundings when working and walking around job site.
	BIOLOGICAL	Be aware of surroundings, apply insect repelent as needed.
	OTHER	none

Personal Protective Equipment Level Definitions

Level D

Level D protection is assigned when minimal protection is warranted. Level D offers protection from nuisance contamination only and is made up of a typical work uniform for the work to be performed. Level D protection includes the following:

Hard hat, safety glasses, hearing protection (as required), gloves, and steel toe boots.

Level C

Level C protection is assigned when the type(s) and concentration(s) of contaminants is known and the criteria for using an air-purifying respirator are met. Level C is an upgrade from level D and in addition to the requirements of level D, the following requirements must be met:

Level D plus Full-face or half-mask air purifying canister/cartridge equipped respirator, hooded chemical resistant clothing, and inner and outer chemical resistant gloves.

Level B

Level B protection is assigned when the type(s) and concentration(s) of contaminants is unknown or is known and warrants the highest level of respiratory protection with a lesser level of skin protection. Level B is an upgrade from level C and in addition to level C requirements, the following requirements must be met:

Level C plus pressure-demand full-face SCBA or pressure demand supplied air respirator with escape SCBA.

Level A	Level A protection is assigned when the atmosphere is IDLH (Immediately Dangerous to Life and Health) and warrants the highest degree of respiratory protection and skin protection. Level A is and upgrade from level B and in addition to level B requirements, the following requirements must be met. **Level B plus totally encapsulating chemical-protective suit.**

CARTRIDGE CHANGEOUT SCHEDULE

Cartridge Changeout Schedule:	As needed, depending on conditions.
Method Used to Determine Schedule:	Change cartridge if it becomes visibly dirty or difficult to breathe.

Decontamination Plan

Personal Decontamination

The section outlining task by task risk assessment and protection plan specifies the level of protection required for each task. Consistent with the level of protection required, step by step procedures for decontamination for each level of protection are given below.

Soil and sediment adhering to boots and waders will be removed prior to leaving the facility. Disposable chemical resitant gloves will be disposed of in a trash recepticle for disposal at a sanitary landfill. Workers will wash hands prior to eating and avoid hand mouth contact while collecting data and samples.

Levels of Protection Required for Decontamination Personnel

The level of protection required for a person assisting with decontamination is:

LEVEL: D

Modification: (upgrade or downgrade) will be made under the following conditions:

If conditions arise such that upgrading to Level C may be required, personnel will stop work, move away from the area of concern, assess the situation and contact the project manager prior to proceeding with work.

Disposition of Contaminated Wastes

The following outlines the protocol to be followed for contaminated wastes that are encountered:

Disposable equipment will be disposed in a waste recepticle for disposal at a sanitary landfill. Soil excavated from test pits will be temporarily stockpiled adjacent to the the test pit then backfilled following sample collecting and logging.

Sampling Equipment Decontamination

The following outlines the protocol to be followed for decontamination of sampling equipment:

Sampling equipment will be decontaminated according to the Sampling and Analysis Plan and associated SOPs

Non-Sampling Equipment Decontamination

The following outlines the protocol to be followed for decontamination of non-sampling equipment:

Soil and sediment adhering to non-disposable PPE will be removed and the equipment rinsed prior to leaving the facility. Large areas of mud adhering to vehicles will be removed prior to leaving the facility.

Contingencies

Emergency Contacts and Phone Numbers

Agency	Contact	Phone Number
Tt Emergency Contact for the Project	Allan Kirk	(406) 582-8780
24 Ambulance Service	Lincoln Ambulance Emergency	911
Fire Department	Lincoln Volunteer Fire Department Emerg.	911
Police Department	Lewis & Clark County Sherriff	911
Onsite Coordinator	Natalie Morrow - Tetra Tech	(406) 543-3045 / (406) 370-8170
Site Telephone	Satellite phone	TBD
Nearest Telephone	Conoco Station in Lincoln, MT	

In the event of an incident, the TT-MM reporting protocol requires that a corporate contact be notified as soon as possible.	Yvonne Freix	**Office:** 715-845-4100 **Mobile:** 800-976-2524 **Home:** 715-355-4193
	Stacy Meacham	**Office:** 402-933-1345 **Mobile:** 402-651-6675 **Home:** 402-933-7763
	Anita Carrico	**Office:** 214-953-3111 (285) **Mobile:** 469-585-8931
	Tory Fravel	**Office:** 970-223-9600 **Mobile:** 970-481-0883 **Home:** 970-266-9409

Local Medical Emergency Facility(s)

Name of Hospital:	St. Peters Hospital	**Distance:**	54 miles
Address:	2475 E. Broadway Street, Helena, MT 59601	**Time:**	1 hr 4 min
	(406) 444-2150 Emergency Department		
Type of Service:	Emergency, trauma		

Route: From the intersection of Mike Horse Creek Road and Highway 200, turn left (west) onto Highway 200 and follow for 4.5 miles. Turn left (south) onto Highway 279 to Flesher Pass. Follow Highway 279 for 38.9 miles to Interstate 15 and merge onto I-15. Follow I-15 for 7.7 miles and take exit 192 for US-12/US 287 S toward Townsend/Capitol Area. Follow for 0.3 miles and turn right at Prospect Ave (US-12 W). Follow for 0.2 miles and turn left at N Fee St for 407 feet and continue on 11th Avenue for 0.3 miles. Turn right at California Street and follow for 0.4 miles then turn left at E. Broadway Street, hospital is on the right.

In the case of a **SERIOUS OR LIFE-THREATENING EVENT** (any injury, accident or near-miss event):
1. Seek emergency medical treatment immediately
2. Once the injured person(s) is appropriately cared for, call a corporate contact listed on the emergency wallet card and update the employee's supervisor and project manager as soon as possible.

Secondary Provider (Local Medical Clinic)

Name of Med Clinic:	Parker Medical Center	**Distance:**	15 miles
Address:	2463 W. Montana Highway 200, Lincoln, MT 59639	**Time:**	15 minutes
	(406) 362-4603		
Type of Service:	Family medical clinic		

Route: From intersection of Mike Horse Creek Road and Highway 200, proceed west 15 miles on Montana Highway 200 to Lincoln, MT to the clinic.

In the case of a **NON-EMERGENCY/NON-LIFE THREATENING INCIDENT** (any injury, accident or near-miss event) call one of the corporate contacts listed on the wallet card (and above) prior to an Employee visiting a physician and implementing the following procedure:
1. Administer first aid immediately.
2. Tetra Tech employees call WorkCare (Tetra Tech contracted physicians) at 1-800-455-6155 for a triage call/discussion with an Occupational Health Nurse (OHN).
3. Mention that this is regarding an injury. At this point the nurse/physician will assist the employee/supervisor/H&S Coordinator to determine the best treatment plan. For example, he/she will recommend first aid or urgent care.
4. WorkCare will require the following information when a call is placed: Name of person calling, phone number, location, name of person injured, Social Security number, date and type of injury.

Tertiary Provider (Occupatinal Health Clinic)

Name of Occ Clinic:	Helena Physicians Clinic	**Distance:**	50 miles
Address:	3330 Ptarmigan Lane, Helena, MT 59602	**Time:**	60 minutes
Type of Service:	Occupational health clinic		

Route: From the intersection of Mike Horse Creek Road and Highway 200, turn left (west) onto Highway 200 and follow for 4.5 miles. Turn left (south) onto Highway 279 to Flesher Pass. Follow Highway 279 for 36.5 miles and turn right at Green Meadows Drive and follow for 6.2 miles. Turn left at west Custer Ave and follow for 1.1 miles. Turn left at Dredge Drive, follow for 0.1 miles, then turn on Road Runner Street and follow for 0.2 miles. Turn right at Ptarmigan and follow for 341 feet.

In the case of a **NON-EMERGENCY/NON-LIFE THREATENING INCIDENT** (any injury, accident or near-miss event) call one of the corporate contacts listed on the wallet card (and above) prior to an Employee visiting a physician and implementing the following procedure:
1. Administer first aid immediately.
2. Tetra Tech employees call WorkCare (Tetra Tech contracted physicians) at 1-800-455-6155 for a triage call/discussion with an Occupational Health Nurse (OHN).
3. Mention that this is regarding an injury. At this point the nurse/physician will assist the employee/supervisor/H&S Coordinator to determine the best treatment plan. For example, he/she will recommend first aid or urgent care.
4. WorkCare will require the following information when a call is placed: Name of person calling, phone number, location, name of person injured, Social Security number, date and type of injury.

Response Plans

Medical - General

First Aid Kit:	**Type:**	Portable	**Special First Aid Precautions:**	
	Location:	Field vehicle	**Hydrofluoride on Site:**	N
Eye Wash:	**Required?:**	Y	**Cyanides on Site:**	N
	Location:	Field vehicle	**Other:**	
Safety Shower:	**Required?:**	N	None	
	Location:	not applicable		

Special Procedures: Consult MSDS for appropriate first aid measures related to chemical exposures. Seek immediate medical attention when incidents warrant anything beyond minor first aid response.

Give other specifics if any. Indicate whether or not the buddy system will be required and when and also the requirements for CPR/First Aid trained personnel on site.

Fire/Explosion

Special Procedures: Give specific procedures to follow if any. Example: Use available fire extinguisher to extinguish small fires. For any fire beyond the control of a portable fire extinguisher contact the local firefighting authorities as listed in the emergency contact section of this plan.

Fire Extinguisher:
Type: Example: ABC
Location: Field vehicle

Spill Response

Special Procedures: No spills are anticipated.

Special Gear:
Type: None
Location: None

Weather/Natural Disaster Emergency

Special Procedures:

If weather or natural disaster emergency, meet at pull-off for Mike Horse Creek Road and Montana Highway 200.

Security Measures

All equipment not removed from the facility at the end of the day wil be stored in the on-site storage container box. The box will be locked at the end of each day and during the day when personnel are not occupying the storage container area.

Site Map

Attached is a site map.

Site Personnel and Certification Status

Name:	Natalie Morrow	**Medical Current:**	Y
Title:	Hydrogeologist	**HAZWOPER Current:**	Y
Task(s):	1,2,3,4,5	**Fit Test Current:**	Y
CPR/First Aid:	American Red Cross		
Other:	OSHA 8-hr Supervisor Training		
Name:	Danny Ernest	**Medical Current:**	Y
Title:	Geologist	**HAZWOPER Current:**	Y
Task(s):	2,3,4	**Fit Test Current:**	Y
CPR/First Aid:			
Other:	OSHA 8-hr Supervisor Training		
Name:	Jim Maus	**Medical Current:**	Y
Title:	Hydrogeologist	**HAZWOPER Current:**	Y
Task(s):	1	**Fit Test Current:**	Y
CPR/First Aid:	Mt. Dept of Labor and Industry		
Other:	OSHA 8-hr Supervisor Training		
Name:	Randy English	**Medical Current:**	Y
Title:	Engineer	**HAZWOPER Current:**	Y
Task(s):	2,3,4	**Fit Test Current:**	
CPR/First Aid:	Mt. Dept of Labor and Industry		
Other:	OSHA 8-hr Supervisor Training		

HEALTH AND SAFETY PLAN (HASP)

UBMC - Remedial Investigation AT Mike Horse Creek Road, Montana

Name:	Don May	**Medical Current:**	Y
Title:	Scientist	**HAZWOPER Current:**	Y
Task(s):	1,2,3,4	**Fit Test Current:**	Y
CPR/First Aid:	OSHA 8-hr Supervisor Training		
Other:			
Name:	Liz Fagan	**Medical Current:**	Y
Title:	Engineer	**HAZWOPER Current:**	Y
Task(s):	2,3,4	**Fit Test Current:**	Y
CPR/First Aid:			
Other:			
Name:	Thad Jones	**Medical Current:**	Y
Title:	Biologist	**HAZWOPER Current:**	Y
Task(s):	2,3,4,5	**Fit Test Current:**	Y
CPR/First Aid:	State of Montana		
Other:			
Name:	Shane Matolyak	**Medical Current:**	Y
Title:	Scientist	**HAZWOPER Current:**	Y
Task(s):	2,3,4	**Fit Test Current:**	Y
CPR/First Aid:	Dept of Labor and Industry		
Other:	OSHA 8-hr Supervisor Training		
Name:	Katie Schultz	**Medical Current:**	Y
Title:	Scientist	**HAZWOPER Current:**	Y
Task(s):	2,3,4	**Fit Test Current:**	Y
CPR/First Aid:			
Other:	OSHA 8-hr Supervisor Training		

Medical Current:	All personnel, including visitors entering the exclusion or contamination reduction zones must be certified as medically fit to work and to wear a respirator if appropriate.
Training Current:	All personnel, including visitors entering the exclusion or contamination reduction zones must have certifications of completion of training in accordance with OSHA 29 CFR 1910.120.
Fit Test Current:	All personnel, including visitors entering any area requiring the use or potential use of any negative pressure respirator must have at a minimum, a qualitative fit test administered in accordance with OSHA 29 CFR 1910.134 or ANSI within the last 12 months. If site conditions require the use of a full face negative pressure air purifying respirator for protection against asbestos or lead, employees must have a qualitative fit test in accordance with OSHA 20 CFR 1910.1002 or 1025 within the last 6 months. * Bearded workers, who can not be fit-tested for a tight face fitting respirator, are required to wear a powered air purifying respirator (PAPR).
Note:	These requirements should be verified for any subcontractor personnel assigned to the site.

Training and Briefing Topics

Note: The following topics will be covered as indicated (i.e., the initial site training, daily, monthly or periodically). Delete the X's corresponding to the topics that do not apply to this site. Indicate the frequency for the topics that do apply.

Site characterization and analysis (29 CFR 1910.120 i)	X	Initially, daily
Physical Hazards	X	Initially, daily

Chemical Hazards	X	Initially, daily
Drilling Safety	X	Initially, daily
Heavy Machinery	X	Initially, daily
Backhoe	X	Initially, daily
Equipment	X	Initially, daily
Tools	X	Initially, daily
Overhead and Underground Utilities	X	Initially, daily
Unguarded Openings	X	Initially, daily
PPE (29 CFR 1910.120 g; and 1910.134)	X	Initially, daily
Respiratory Protection (29 CFR 1910.120 g; and 1910.134)	X	Initially, daily
Level D - Personal Protective Equipment	X	Initially, daily
Decontamination (29 CFR 1910.120 k)	X	Initially, daily
Emergency Response (29 CFR 1910.120 l)	X	Initially, daily

Other Drilling Considerations

Unfilled Bore-holes

Will bore-holes be drilled and need to be left unfilled for a period of time? Yes

If yes, length of time before filled or well installed. 1-2 days

Safe guarding requirements:

The requirements for safeguarding may vary with the type of site. However one of the following must be chosen based on the following guidelines or equivalent must be chosen and spelled out here. If drill rig is removed from the borehole, and the hole is in an unpaved or remote location, the hole can be 1) covered with a piece of 1/2 inch minimum thickness plywood or other similar means and an orange safety cone should be placed on top of the plywood; 2) or if the hole is in an unpaved and remote location, the hole can be demarcated by using poles or stakes and rope or barricade that prevents access by people or large animals. NOTE: All holes must be marked to make individuals aware that there is a potential hazard. The means can be chosen based on the site and should be detailed in this section.

Filling Bore-holes

Will bore-holes be drilled which require filling? Possibly

Procedure for backfilling of bore-holes

Boreholes may be filled if no water is encountered and no well installed. If boreholes are filled, they must be filled in in such a manner that settlement will not occur presenting a hazard. The method chosen can be based on the site and should be detailed in this section. Acceptable methods include: 1) Ensuring that tremie holes are full or 2) Installing a concrete cap much larger than the borehole.

Other Site Specific Drilling Concerns:

Drilling will be used in areas of steep terrain. Prior to drilling and during drilling, the driller must ensure the drill rig is set up properly and on stable ground to prevent the rig from tipping.

Intrusive Activities Checklist

Will intrusive activities be performed for work under this HASP? Y

If yes, describe the type(s) of intrusive activity. Excavating test pits with excavator and by hand, and drilling boreholes.

Subsurface Structures Present Remote location, utilities likely in areas near water treatment facilities.

Type	Present?	Located ?	Method Used/To Be Used for Locating
Electrical	Yes-Northwestern Energy Installed 9-2007 along access road	Yes	One-call locating company
Gas	None	not applicable	not applicable
Water	Yes	Will be prior to project	Will be located by field personnel with a metal detector.

Shut-Offs Located

Type	Location of Shut-Off
Electrical	not applicable
Gas	not applicable
Water	not applicable

Emergency Contacts for Subsurface Structure Repair

Type	Appropriate Contact for Emergency Repair of Specific Subsurface Structure Type/Material
Electrical	not applicable
Gas	not applicable
Water	not applicable
Product	not applicable
Other	not applicable

Procedure for Ensuring Unknown Substructures Identified

Although potential known and unknown subsurface structures are identified per the above sections, there is always the potential for unkown subsurface structures to be encountered during intrusive activities. Therefore, a protocol needs to be established for each particular site. For this site, the following procedures will be followed for the intrusive activities identified above: (Delete the X's in front of the procedure(s) that do not apply to this site.)

X	"One Call" or equivalent utility locate per the local system for the site will be made (this is mandatory on all sites)
X	Local one-call utility locate contractor.

Required PPE and Equipment Checklist

Delete the X's corresponding to the PPE/Equipment that does not apply to this site.

SAFETY GLASSES WITH SIDE SHIELDS			X	
HARD HAT			X	Drill rig & Excavator
STEEL-TOED BOOTS			X	
GLOVES	TYPE:		X	
RESPIRATOR	TYPE:		X	
RESPIRATOR CARTRIDGES	TYPE:		X	
HEARING PROTECTION	TYPE:		X	
HIGH VISIBILITY WEAR	TYPE:	Orange hunting vests, etc.	X	
LIFE VESTS	TYPE:	When wading and working in the marshes	x	
WASTE DISPOSAL BAGS / LABELS			X	
FIRE EXTINGUISHER			X	
EYE WASH BOTTLE			X	
FIRST AID KIT			X	
DRINKING WATER			X	
WASH WATER			X	
SOAP			X	

INSECT REPELLENT	X	
UV PROTECTION	X	
FOOD	X	
TOOL KIT	X	

FIELD AUDITS

A field auditing program should be determined for the project based on the scope of work, duration of the project and degree of hazards associated with the tasks involved.

During the course of this project a minimum number of field audits will be conducted as follows:	1 per Task
The following person is responsible for ensuring the audits and associated corrective actions are completed:	Field Task Leaders & Site Supervisor

PROVISIONS FOR LONE WORKERS

Will Tetra Tech employees or subcontractor employees be required to or have the potential to work alone?	Yes
For which task(s) will a site worker be or have the potential to be working alone?	1, 2, 3, 4
List the type of employees that will be permited to work alone and under what conditions:	Tetra Tech

Workers may work alone when travelling in a vehicle from one location to another, when one worker is briefly away from the sampling location (i.e. to haul supplies to site), brief hiking or walking from one location to another, or when working in a vehicle or at the storage container preparing samples for shipment to the laboratory. Personnel shall work in pairs when working around water and wading through the marshes. No one shall wade through the marshes alone.

Note: Personnel should not be allowed to work alone if there is high hazard potential associated with the site and/or task they will be performing, including but not limited to high physical hazard potential (such as heavy equipment operation, high voltage, intrusive activities, etc.), potential for extreme acute chemical exposure, high crime areas, remote sites, etc.

Lone Worker Check-In Procedure

Detail a daily check-in procedure for all site personnel who will be working alone. Note: There may be a need to detail different check-in procedures for different tasks, personnel etc.

Form of communication to be used for check-in:	Example: Radio
Primary check-in person:	Natalie Morrow or acting Site Supervisor. Site Supervisor will maintain contact with one or more field task leader throughout the day.
Alternate check-in person:	Acting Site Supervisor or Project Manager if single worker in field.

Check-In Schedule

X	Initial Check-In:	No person is expected to work alone for more than 20 to 30 minutes except Site Supervisor or task leader that may be preparing samples for shipment. If a person is working alone in the field, the person shall check-in prior to work for day with Site Supervisor.
X	Periodic Check-In:	If person has planned with Project Manager or Site Supervisor to work alone for the day or partial day, the work shall check-in at a minimum of every 4 hours with radio or satellite phone, or as arranged with Site Supervisor or Project Manager prior to beginning work task(s).
X	Final Check-Out:	Lone worker will check-in with Site Supervisor or Project Manager at end of day after all equipment and supplies have been packed up and the worker is leaving the site for the day.

Tetra Tech Compliance Agreement Form

PROJECT SCOPE: Tetra Tech has been contracted by DEQ to perform a remedial investigation to fill data gaps remaining after previous investigation. The investigation will include installation and sampling of bedrock wells and groundwater sampling of existing wells; surface water and sediment sampling, soil sampling, and

PROJECT NUMBER: 115 7561589

I have read, understood, and agree with the information set forth in this Health and Safety Plan along with any related attachments and discussed in the Personnel Health and Safety briefing.

NAME	SIGNATURE	DATE

HEALTH AND SAFETY PLAN (HASP)

UBMC - Remedial Investigation AT Mike Horse Creek Road, Montana

Subcontractor Notification of Hazards Acknowledgement Form

PROJECT SCOPE: Tetra Tech has been contracted by DEQ to perform a remedial investigation to fill data gaps remaining after previous investigation. The investigation will include installation and sampling of bedrock wells and groundwater sampling of existing wells; surface water and sediment sampling, soil sampling, and

PROJECT NUMBER: 115 7561589

I am aware that Tetra Tech has provided this Health and Safety Plan for my review to inform me of the hazards identified with the project site and tasks that Tetra Tech will perform. I understand that this Health and Safety Plan does not fulfill requirements for subcontractor health and safety plans related to the tasks which they will perform.

NAME	SIGNATURE	DATE

APPENDIX A-2
STANDARD OPERATING PROCEDURES

SOP-01

STANDARD OPERATING PROCEDURE

STREAMFLOW MEASUREMENT; WADING TECHNIQUE

1. Visually check wading rod, current meter (pygmy or AA types), and headsets for damage. Repair damage to equipment and replace batteries in headsets as necessary.

2. Evaluate reach of stream to determine type of meter necessary to make flow measurement. For shallow, low velocity streams, use a pygmy-type current meter; for relatively deep, higher velocity streams, use a standard AA-type meter.

3. Perform spin test on selected meter; the cups on the pygmy meter should spin continuously for at least 30 seconds; on the AA meter, the cups should spin for at least two minutes. If the current meter fails the spin test, lubricate and adjust as necessary to achieve desired results.

4. Attach current meter and head set to wading rod. Check the electric connection between the current meter and headset by spinning cups on the current meter and listening for clicks in the head phone. Adjust equipment as necessary such that a clear click is heard upon every revolution of the cups.

5. Anchor surveyor's tape tautly across the stream perpendicular to the direction of streamflow and attach on either side of the stream. Provide at least one foot of clearance between the water surface and surveyor's tape.

6. Divide the stream cross-section into an appropriate number of sections with approximately equal flow in each section. Concentrate measurements in areas of most flow. A very small stream may have only a few sections; a river should have 20 to 30 sections.

7. Person wading in stream calls out to data recorder on shore the location of the first measuring point with respect to the surveyor's tape. Person in stream measures water depth at that vertical, using wading rod, to the nearest one-hundredth of a foot, if possible.

8. Data recorder calls out height(s) above the streambed at which velocity measurements are to be made. If the water is more than 2.5 feet deep, measurements should be made at 20 and 80 percent of the water column height. For water columns less than 2.5 feet deep, a single measurement of velocity at 40 percent of the water column height will suffice. Person wading adjusts height of current meter on the wading rod accordingly.

9. Person wading stands downstream of the surveyor's tape, facing upstream, holding the wading rod vertical in the water with the current meter facing directly into the current. Person should not stand directly behind the meter but either to the left or right so as not to influence velocity readings.

10. Person wading counts clicks at each vertical for a minimum of 40 seconds and calls final tally of both number of clicks and time to data recorder. Click count should correlate with velocity chart provided with each meter.

11. Repeat procedure at each vertical.

12. Data recorder reduces data on-site and records other appropriate information on the field form.

13. Streamflow measurement data are reduced using the attached form. Further information can be found in: Rantz et al 1982. Measurement and Computation of Streamflow: Volume 1 - Measurement of Stage and Discharge, Volume 2 - Computation of Discharge. U. S. Geological Survey Water-Supply Paper 2175.

STANDARD OPERATING PROCEDURE

SURFACE WATER SAMPLING

EQUAL DISCHARGE INTEGRATED SAMPLING

1. Visually check DH-48 or D-74 sediment sampler for damage. Replace or repair parts as necessary.

2. Decontaminate all parts of the sampler including nozzle, body, gasket, sample collection bottle, and handle using the procedure outlined in SOP-11.

3. Following streamflow measurement, and utilizing the same tag line or surveyor's tape stretched across the stream, divide the stream into an appropriate number of sections of equal discharge based on stream gaging results. At the mid point of each equi-discharge section, lower the sampler into the stream with one continuous motion making sure the sample handle is vertical. Lower the sediment sampler to the streambed at a rate based on the rating curve for the nozzle size used and the velocity of the stream. The sample bottle should be just under half full upon encountering the streambed. Raise the sampler at a rate similar to the descent rate. Low velocity streams are slow to fill the sample bottle; repeat the procedure until sampler is nearly full. The sample bottle should not be completely full upon removal from the stream. Pour contents of sample bottle into a churn splitter or into an appropriately sized compositing container.

4. Repeat procedure for the other equal discharge sections identified, composite collected samples.

5. Mix composite sample, fill out bottle labeling information, and fill the appropriate sample bottle.

6. Fill out appropriate field form documenting sample location, time, and other pertinent information prior to leaving sampling site.

GRAB SAMPLING

1. Decontaminate sampling container in accordance with SOP-11.

2. Locate sampling point if feasible at the interval in the stream which exhibits the largest volume of flow and/or highest velocity. More than one interval may be sampled.

3. Submerge sample container at sampling point such that mouth of container is under water surface 2 to 3 inches, if possible. If sampling inorganics, allow container to fill partially; rinse container by shaking and discharge this water away from sample site. Repeat this procedure three times. Do not rinse sample bottles for organics analysis.

4. Collect sample and transfer into compositing container. Transfer water from compositing container into pre-labeled sampling bottles.

5. Fill out appropriate field form(s) documenting sample location, time, and other pertinent information prior to leaving sampling site.

SURFACE SAMPLING

1. This sampling procedure is to be used when sampling for organic constituents that float on top of water (e.g. oil and grease).

2. Decontaminate sampling container in accordance with SOP-11. The sampling container should be a wide mouth jar.

3. Submerge the sampling container in such a manner that leaves the mouth of the container half-way out of the water. Wait for container to fill.

4. Transfer directly into sampling bottles.

5. Fill out appropriate field form(s) documenting sampling location, time and other pertinent information prior to leaving the sampling site.

SOP-04

STANDARD OPERATING PROCEDURE

FIELD SAMPLE FILTRATION

1. Filtration equipment should include either disposable 0.45 micron filters or glassware to field filter water samples through a 0.45 micron filter paper. Visually inspect filtration equipment for damage. Replace parts or repair equipment as necessary.

2. Vacuum-type filtration apparatus will be decontaminated in accordance with SOP-11.

3. Place 10-15 milliliters of 10% dilute nitric acid into filter apparatus containing 0.45 micron filter. Apply vacuum, discard filtered solution.

4. Repeat above procedure three times using sample water. Discard filtrate. If unable to repeat three times, use a pre-filter before using the 0.45 micron filter.

5. Fill filter vessel with sample water and apply vacuum. Use small quantities of filtered water to rinse sample container three times.

6. Fill labeled sample container to appropriate level with filtered sample and mark level with permanent marker. Add appropriate preservative, if necessary. Invert sample container several times to insure complete sample - preservative mixing.

7. Place sample container into cooler; package and ship in accordance with SOP-09.

8. If extremely turbid sample water is obtained, use same procedure using a pre-filter (usually 3.0 or 5.0 micron paper) followed by 0.45 micron filtration.

9. Decontaminate all equipment in accordance with SOP-11 following use.

STANDARD OPERATING PROCEDURE

FIELD MEASUREMENT OF ELECTRIC OR SPECIFIC CONDUCTANCE (EC/SC)

INSTRUMENT CALIBRATION (for non-temperature compensating meters)

At the beginning each day of making measurements, determine the cell constant for the meter in the field or lab.

1. Turn on machine and check red line and zero point on meter. Adjust as necessary. If unable to reach red line, or zero point, replace D cell batteries.

2. Plug probe into jack, and rinse probe with deionized water.

3. Measure conductivity and temperature of two KCl solution standards which best bracket the expected EC/SC of the sample.

4. Calculate EC/SC using the following chart to adjust conductivity measurement for temperature correction.

TEMPERATURE CORRECTION TABLE

TEMP °C	FACTOR	TEMP °C	FACTOR	TEMP °C	FACTOR
-1	1.89	8	1.46	17	1.18
0	1.84	9	1.42	18	1.15
1	1.79	10	1.38	19	1.13
2	1.74	11	1.35	20	1.10
3	1.68	12	1.32	21	1.08
4	1.63	13	1.29	22	1.06
5	1.58	14	1.26	232	1.04
6	1.54	15	1.23	24	1.02
7	1.50	16	1.20	25	1.00

5. Use the following procedure to calculate cell factor:

SC of Standard_______________(a)　　Temperature of Standard _________________

Instrument Reading____________　　Temperature Correction Factor (from above table)

Temp.Corrected SC___________(b)　　Cell Correction Factor ___________________________
[divide (a)/(b)]

6. The cell factor is calculated for each standard and then averaging the values from the two standards. The cell correction factor is the ratio of the actual conductivity of the standard KCl solution(a) to the computed conductivity(b). Use the averaged value of the two standards to adjust the measured field conductivity for each sample taken during the day.

FIELD PROCEDURE

1. Turn on machine and check red line and zero point on meter. Adjust as necessary. If unable to reach red line, or zero point, replace D cell batteries.

2. Rinse decontaminated glass beaker with approximately 50 milliliters of sample water three times.

3. Place approximately 150 ml. of sample in decontaminated glass beaker.

4. Rinse probe with deionized water and place conductivity probe in sample water.

5. Immerse conductivity probe in sample so that vent hole is submerged. Move probe around in sample to displace any air bubbles. The probe should not be touching the sides of the beaker. Turn instrument to appropriate scale for sample being analyzed. Multiply reading by the correct multiplier from the dial and record to the nearest ten micromhos/centimeter. Measure sample temperature to nearest 0.5^{o}C from conductivity meter.

6. Record temperature and conductivity reading on the sample field form. Compute the adjusted specific conductivity using the following procedure:

   Water Temp. ___________________________ Observed SC (a) ______________

   Temperature Correction (from table) (b) ____________________________
   Cell Correction Factor (from above) (c) ____________________________
   Adjusted Sample SC [multiply (a)(b)(c)] ____________________________

7. Remove probe from sample and rinse probe with DI water. Store probe in deionized water to protect coating.

MAINTENANCE

1. Store meter in its case during transport. Store probe immersed in deionized water (a poly bottle with rubber stopper works well).

2. Check batteries before taking meter into the field. Carry spare batteries and screwdriver.

3. Inspect conductivity electrodes regularly for cracks or other damage.

4. If platinum black has flaked off, a sharp end point cannot be achieved or readings are erratic. Return probe to factory so it can be replatinized.

STANDARD OPERATING PROCEDURE

FIELD MEASUREMENT OF pH

INSTRUMENT CALIBRATION

1. Calibrate pH meter before leaving for the field and each day in the field when pH will be measured. Calibrate using following procedure:

   - Rinse pH electrode and temperature probe with distilled water.

   - Immerse electrode and temperature probe in bottle of commercial calibration solution of pH buffer 7.0. Calibrate meter to within 0.1 standard unit (s.u.).

   - Remove electrode and temperature probe from solution, rinse with distilled water.

   - Immerse electrode and temperature probe in second pH calibration buffer having a pH of 3 units higher or lower than the first, bracketing the expected range of natural sample pH.

   - The pH meter should be recalibrated during the field day, especially when air temperatures are changing by 5 or more degrees. To recalibrate pH meter, measure pH of the 7.0 buffer solutions. If the measured value differs from expected value by more than 0.1 units, recalibrate meter using according to meter instructions.

FIELD PROCEDURES

1. Rinse decontaminated glass beaker with approximately 50 milliliters of sample water three times.

2. Rinse pH electrode with deionized water.

3. Check meter using 7.0 pH buffer. Re-calibrate meter, if not within 0.1 pH units.

4. Fill beaker with sample water.

5. Immerse electrode and temperature probe in sample, agitate probes to provide thorough mixing. Continue to agitate until reading has stabilized. Read pH to nearest 0.1 s.u.

6. Record the sample pH. Note any problems such as erratic readings.

7. Rinse probe with DI water and store according to manufacturer's directions.

MAINTENANCE

1. Store meter in its case with electrode immersed in a KCl or pH 7.0 buffer solution.

2. If meter is not used often, inspect bi-weekly to make sure electrode is immersed in one of the solutions described above.

3. Check batteries each time meter is used. Carry a spare battery pack and a screwdriver into the field in the pH meter case.

4. It is wise to keep an additional pH electrode available in case of probe malfunction or breakage. Usually probes are replaced as their sensitivity becomes weakened. If stabilized readings take an unusually long time to reach, or the meter cannot be calibrated.

SOP-07

STANDARD OPERATING PROCEDURE

FIELD MEASUREMENT OF WATER TEMPERATURE

1. Carry two NBS-calibrated thermometers inside cases, into the field.

2. Check thermometer for cracks or gaps in the solution. Do not use thermometers if either cracks or gaps are visible. (Some gaps can be closed by submersing tip in a beaker of boiling water, or placing thermometer in a freezer).

3. When possible, measure temperature of surface water at midstream submersing the thermometer for approximately one minute or until temperature stabilizes. Temperatures should be collected from moving water, avoiding still pools which may be warmer than actual conditions.

4. When in situ temperature measurements are not possible, draw sample of at least 200 mL into a decontaminated beaker or sample bottle as soon after sampling as possible.

5. Place thermometer in sample. Do not allow thermometer bulb to touch sides of beaker. Allow to equilibrate (about 1 minute).

6. Record temperature to nearest 0.5^{o}C in field log book or on field data sheet.

7. Rinse thermometer with deionized water.

8. On a quarterly basis, check field thermometers against a NBS-certified laboratory thermometer. Agreement should be within 0.5^{o}C.

STANDARD OPERATING PROCEDURE

FIELD MEASUREMENT OF DISSOLVED OXYGEN

1. Inspect dissolved oxygen (DO) meter for damage. The probe end should be examined to be sure the membrane is intact. Repair as necessary according to manufacturer's instructions.

2. Rinse probe and cable with Deionized water.

3. Prepare probe and DO meter in accordance with instrument manufacturer's operating procedures (in meter box). Make certain probe contains sufficient electrolyte and the oxygen sensor membrane is in good repair.

4. Calibrate probe and meter using the fresh water - air calibration method. Correct calibration value for temperature and altitude; adjust meter accordingly.

5. When possible place probe directly into the stream, or water to be measured. If not possible, place probe into beaker filled with sample. Manually raise and lower probe through sample about 1 foot/second. Allow sufficient time for probe to stabilize to sample temperature and dissolved oxygen concentration.

6. Read dissolved oxygen value. Record appropriate data on field forms.

SOP-09

STANDARD OPERATING PROCEDURE

SAMPLE PACKAGING AND SHIPPING

All environmental samples collected should be packaged and shipped using the following procedures:

PACKAGING

1. Label all sample containers with indelible ink (on the side, not on the cap or lid). Place labeled sample bottles in a high quality cooler containing an adequate amount of ice and/or frozen blue ice (appropriate for the season), making sure the cooler drain plug is taped shut.

2. Place the samples in an upright position and wrap the samples with absorbent, cushioning material for stability during transport. Samples should not be loose; the cooler should be able to withstand rough handling during shipment without sample breakage.

3. Fill out the appropriate shipping forms, and place the paperwork in a ziploc bag and tape it to the inside lid of the shipping container. Shipping forms usually include: 1) a chain-of-custody form, documenting the samples included in the shipment; 2) an analysis request form, specifying the laboratory analyses for each sample. If more than one cooler is used per chain of custody, put a photocopy in the other coolers and mark them as a copy.

4. Close and seal the cooler using fiberglass strapping tape.

5. Secure the shipping label with address, phone number, and return address clearly visible.

SHIPPING HAZARDOUS MATERIALS/WASTE

Hazardous materials need to be shipped using procedures specified under Federal Law. Samples need to be shipped in ziploc bags or paint cans filled with vermiculite, depending on the level of hazard. Special package labeling may be needed. Consult the project manager for specific shipping procedures.

SOP-10

STANDARD OPERATING PROCEDURE

FIELD FORMS

All pertinent field investigations and sampling information shall be recorded on a field form during each day of the field effort and at each sample site. The field crew leader shall be responsible for ensuring that sufficient detail is recorded on the field forms. No general rules can specify the extent of information that must be entered on the field form. However, field forms shall contain sufficient information so that someone can reconstruct all field activity without relying on the memory of the field crew. All entries shall be made in indelible ink, weather conditions permitting. Each day's or site's entries will be initialed and dated by the author.

At a minimum, entries on the field sheet or in field notebook shall include:

- Date and time of starting work and weather conditions.
- Names of field crew leader and team members
- Project name and type
- Description of site conditions and any unusual circumstances.
- Location of sample site, including map reference, if relevant
- Equipment ID numbers
- Details of actual work effort, particularly any deviations from the field work plan or standard operating procedures
- Field observations
- Any field measurements made (e.g., pH)

For sampling efforts, specific details for each sample should be recorded using Maxim Technologies, Inc. standardized field forms. Surface water and groundwater field forms contain fill-in-the-blank type information in order that all pertinent information shall be recorded. In addition to the items listed above, the following information is recorded on field forms during sampling efforts:

- Time and date samples were collected
- Number and type (natural, duplicate, QA/QC) of samples collected
- Analysis requested
- Sampling method, particularly deviations from standard operating procedures

Strict custody procedures shall be maintained with the field forms. Field forms shall remain with the field team at all times, while being used in the field. Upon completion of the field effort, photocopies of the original field forms will be made and used as working documents; original field forms shall be filed in an appropriately secure manner.

SOP-11

STANDARD OPERATING PROCEDURE

EQUIPMENT DECONTAMINATION

The purpose of this section is to describe general decontamination procedures for field equipment in contact with mine/mill tailings, soil, or water. During field sampling activities, sampling equipment will become contaminated after it is used. Sampling equipment must be decontaminated between sample collection points if it is not disposable. Field personnel must wear disposable latex or vinyl gloves while decontaminating equipment at the project site. Change gloves between every sample. Every precaution must be taken by personnel to prevent contaminating themselves with the wash water and rinse water used in the decontamination process.

Table A-1 lists equipment and liquids necessary to decontaminate field equipment.

The following should be done in order to complete thorough decontamination:

1. Set up the decontamination zone upwind from the sampling area to reduce the chances of windborne contamination.

2. Visually inspect sampling equipment for contamination; use stiff brush to remove visible material.

3. The general decontamination sequence for field equipment includes: wash with Liquinox or an equivalent degreasing detergent; deionized water rinse; 10% dilute nitric acid rinse (if sampling for metals); deionized water rinse; rinse with sample water three times.

4. Rinse equipment with methanol in place of the nitric rinse if sampling for organic contamination. Follow with a deionized water rinse.

5. Decontaminated equipment that is to be used for sampling organics should be wrapped in aluminum foil if not used immediately.

6. Clean the outside of sample container after filling sample container.

Alternatively, field equipment can be decontaminated by steam cleaning, rinsing with 10% dilute nitric acid, and rinsing with deionized water.

All disposable items (e.g., paper towels, latex gloves) should be deposited into a garbage bag and disposed of in a proper manner. Contaminated wash water does not have to be collected, under most circumstances.

If vehicles used during sampling become contaminated, wash both inside and outside as necessary.

TABLE A-1. EQUIPMENT LIST FOR DECONTAMINATION

5-gallon plastic tubs	Liquinox (soap)
5-gallon plastic water-container	Hard bristle brushes
5-gallon carboy DI water	Garbage bags
1-gallon cube of 10% HNO_3	Latex gloves
1-gallon container or spray bottle of	Squeeze bottles
10% Methanol or pesticide grade acetone for organics	Paper Towels

STANDARD OPERATING PROCEDURE

SAMPLE DOCUMENTATION

Sample documentation is an important step to ensure the laboratory, project manager, and field personnel are informed on the status of field samples. Depending on the specifics required for each project, a number of forms will need to be filled out. Most sample documentation forms are preprinted carbonless triplicates, enabling copies to be filed or mailed from labs or offices. The forms will be completed by field personnel, who have custody of the samples. The office copy will be kept in the project file and subsequent copies sent to the laboratory, or other designated parties. The responsibility for the completion of these forms will be with each field crew leader. It is important the field crew leader is certain field personnel are familiar with the completion process for filling out forms, and the expected information is included.

Potential documents to be completed clearly in ink for each sample generated include:

- Field Form
- Chain-of-Custody
- Custody Seal

If working on Superfund activities, the following additional forms will also be prepared:

- EPA Sample Tags
- SAS Packing Lists
- Sample Identification Matrix Forms
- Organic Traffic Report (if applicable)
- Inorganic Traffic Report (if applicable)

STANDARD OPERATING PROCEDURE

QUALITY CONTROL (QC) SAMPLES

Quality Control (QC) samples are submitted along with natural samples to provide supporting laboratory data to validate laboratory results. QC samples typically are submitted blind, and do not have any unique identifying codes that would enable the lab or others to bias these samples in any way. Usually, the time or sampling location is modified in a way which will separate blank and standard samples from the rest of the sample train. QC samples are identified only on field forms and in field notebooks. The following codes are typically used:

N - Natural Sample	Soil, water, air, or other material from a field site
SP - Split Sample	A portion of a natural sample collected for independent analysis; used in calculating laboratory precision
D - Duplicate Sample	Two samples taken from the same media under similar conditions; also used to calculate laboratory precision
BB - Bottle Blank	Deionized water collected in sample bottle; used to detect contamination in sample containers
CCB - Cross Contamination Blank	Deionized water run through decontaminated equipment and analyzed for residual contamination
BFS - Blind Field Standard	Certified chemical constituent(s) of known concentration; used to determine laboratory accuracy
TB - Travel or Trip Blank	Inert material (deionized water or diatomaceous earth) included in sample cooler; sent by the lab, the sample is used to determine if contamination by volatiles is present during collection or shipping

In general, selected QC samples will be inserted into the sample train within a group of 10 to 20 samples. Unless otherwise specified, QC samples will be prepared in the field. Deionized water for bottle blanks and cross-contamination blanks will be collected from carboys and cubitainers used in the field. An exception to field preparation of QC samples is some blind field standards. Since the analytes in some blind field standards are to be mixed according to specific manufacturer's instructions, field conditions may not provide the needed laboratory atmosphere. This is especially true for volatile organic compounds, which need to be prepared just before analyzing. Under these circumstances, such blind field standards will be shipped to the laboratory for preparation, keeping the concentration or manufacturer's QC Lot Number as blind as possible.

The number and types of samples submitted for each group of natural samples will be determined by the project manager and others, including state or Federal agencies, and will be defined in the project work plan. Each field crew leader will be responsible for all QC samples prepared in the field.

Methods for computing data validation statements can be found in EPA documents or obtained from the laboratory.

STANDARD OPERATING PROCEDURE

MONITORING WELL CONSTRUCTION

1. Arrive on-site with properly sized drilling equipment and materials for site conditions. All drilling equipment and materials should be properly decontaminated prior to its arrival on-site. Decontamination usually includes steam - or hot water-cleaning methods.

2. Drilling muds or drilling solutions of any kind are not to be used during drilling activities in conjunction with monitoring well construction. Acceptable drilling techniques include air-rotary, cable tool, or hollow-stem auger. If unconsolidated material is encountered, it may be necessary to drive steel casing during drilling to maintain borehole integrity. It is suggested threaded steel casing be used in lieu of welding joints together to minimize this source of potential well contamination. Hydraulic jacks or the drill rig can be used to pull back the steel casing following emplacement of plastic casing.

3. A detailed lithologic log shall be completed during drilling activities. Water bearing characteristics of the formations should also be denoted on the log. In addition, details of monitoring well construction should also be described on the well log including total depth, perforated interval, sizes and types of construction materials, etc.

4. Seven- or ten-inch outside diameter hollow-stem augers can used in drilling shallow exploration drill holes in many situations. Care is taken to avoid contamination due to oil and grease from the drill rig and split spoon sampler. Appropriate decontamination of the drill rig between drill holes is performed. Soil and sediment samples are collected using a standard 1.4 inch inside diameter split spoon sampler and a 140 pound drive hammer. The number of blows necessary to obtain an 18 inch length of sample is recorded on the exploration log. Appropriate decontamination of the split spoon sampler is accomplished between samples.

   Either a single- or multi-completion monitoring well can be constructed in a single borehole where hollow-stem auger drilling is not used. Backfill with chemically-inert silica sand to above the perforated interval and emplace a bentonite plug above the sand. Install factory-screened and blank PVC (or stainless steel or PTFE for organics) well casing into the borehole. Where appropriate, begin pulling temporary steel casing out of borehole. Emplace silica frac sand above and below any perforated sections in the borehole; install bentonite plugs above and below sand pack around perforated sections. Backfill remaining well annulus with a bentonite slurry or with grout to the surface. Monitoring well development is presented in SOP-17.

5. Place locking well protector over PVC casing(s) after outer steel casing has been removed from the borehole if necessary. Place bentonite plug below bottom of well protector; grout well protector in place and lock with high quality lock.

6. Many states now require certification and licensing for monitoring well drillers. Be sure you know the State's regulations before arriving on-site, especially if drilling outside your own State.

7. Safety equipment required on-site of the drill rig is mandatory. Personal protective equipment includes (at a minimum): hard hat, safety glasses, steel toed boots, gloves, first aid kit, and site safety plan - with routes to hospitals known by all personnel on-site.

STANDARD OPERATING PROCEDURE

MONITORING WELL DEVELOPMENT

1. Visually inspect all well development equipment for damage - repair as necessary.

2. Decontaminate all stingers, air hoses, surge blocks by scrubbing with brush and Liquinox solution, rinsing with dilute nitric acid solution, and rinsing with deionized water. If sampling for organics, replace the nitric acid rinse with 10% methanol as per SOP 11.

3. If using compressed air method for well development, make certain compressor utilized does not produce air laden with hydraulic fluid for lubricating purposes. This may affect the integrity of the monitoring well for producing viable water quality data.

4. Develop well by using surging techniques (surge block or bailer) followed by well evacuation. Repeat this procedure until evacuated water is visibly clean and essentially sand-free. In most cases, evacuated water can be disposed of on-site.

5. If specified in the project workplan, during evacuation process, collect water samples for field determinations of temperature, specific conductivity, and pH. Continue developing well until field parameters stabilize to within ±5% on three consecutive measurements.

6. Report field observations and volume of water removed on standard form.

STANDARD OPERATING PROCEDURE

GROUNDWATER SAMPLING

EQUIPMENT:

- five gallon bucket graduated in gallons
- coolers and ice
- sample bottles
- preservatives
- filter apparatus
- decontamination equipment & fluids
- water level probe
- purge pump(s)
- discharge hose
- pH meter/thermometer (optional)
- specific conductance meter (optional)
- bailer(s)
- bailer rope or teflon reel
- field sampling forms
- indelible marker
- stop watch
- generator
- fuel

All sampling equipment shall be inspected for damage, and repaired if necessary, prior to arriving on-site.

GENERAL PROCEDURE - PURGING

Purging must be performed on all wells prior to sample collection. If required by the project workplan, the stability of pH, specific conductivity, and temperature will be evaluated. A minimum of three volumes of groundwater in the well casing shall be withdrawn prior to sample collection. The volume of water present in each well shall be computed using the length of water column, monitoring well inside diameter, and casing diameter. The total volume of water in the well (gallons) can be approximated using the following formula (depth and water level measurements in feet; borehole diameter in inches):

$$\textbf{(1/25)(Total Depth - Measured Water Level)(Casing Diameter)}^2\textbf{ = gallons}$$

Several general methods are used for well purging. Well purging may be achieved using bailers, bladder pumps and submersible pumps. The specific pumping method shall be chosen based on depth to groundwater, diameter of well, existing well configuration and contaminant(s) of concern. Specific conductance, pH, temperature, and purge volume values will be entered on the Field Sampling Forms. If sampling for hydrocarbon compounds, wells shall be checked for the presence of free product prior to purging and sampling.

If specified by the project workplan, field parameters will be measured periodically during well purging. The well is ready for sampling when either or both of the following conditions are met: 1) measured field parameters stabilize at plus or minus five percent of the reading, over three successive readings or, 2) three to five casing volumes have been evacuated from the well.

If the recovery of a low-yield well exceeds two hours after purging, the sample shall be extracted as soon as sufficient volume is available in the well for a sample to be extracted. At no time will a monitoring well be pumped dry if the recharge rate causes formation water to cascade down the well casing causing an accelerated loss of volatiles and change in pH.

COLLECTING WATER QUALITY SAMPLES

1. Generally, wells shall be sampled from the least contaminated to the most contaminated, if known. Open well and measure water level (SOP-20).

2. Decontaminate sampling equipment using the following procedure: scrub with brush and Liquinox solution; rinse with 10% dilute nitric acid; rinse with methanol, if sampling for organic compounds; rinse three times with deionized water. Use disposal latex or vinyl gloves throughout decontamination and sampling procedure and new gloves for each sampling point.

3. Sampling Monitoring Wells

   a. To collect a water quality sample, use a decontaminated disposable polypropylene, stainless steel, or teflon bailer and a spool of polypropylene rope or equivalent bailer cord (teflon-coated stainless steel cable). Tie a bowline knot through the bailer loop to secure.

   b. Slowly lower bailer or other sample collection device to the bottom of the well and remove an additional 5 feet of rope from the spool. Secure end of rope to steel well casing or wrist.

   c. Purge well by bailing or pumping, collecting evacuated water in a graduated 5 gallon bucket to measure the total volume discharged.

   d. Collect a sufficient quantity of water using the bailer or pump into a decontaminated one gallon sample container to fill all sample bottles.

4. Sampling Domestic Wells

   a. Turn-on household fixture (preferably an outside faucet without a hose connected) that is on the well-side of any household water conditioning device.

   b. Using the above equation, calculate the volume of water to be evacuated. Measure the discharge rate from the faucet in a graduated 5 gallon bucket, or other suitable container, to compute the rate of discharge. Calculate the time needed to evacuate the predicted volume from the well. Record all measurements and calculations on field forms.

   c. Samples should be collected directly from hydrant or faucet and prior to entry of the water through any water conditioning devices. Do not collect samples through rubber hoses.

5. If specified by the project work plan, measure pH and specific conductance (SOP-05 and SOP-06). Continue monitoring field parameters (pH and specific conductance) periodically during purging process. The well is ready for sampling when either or both of the following conditions are met: 1) the purged volume is equal to three to five casing volumes and/or, 2) measured field parameters are within plus or minus five percent ($\pm$ 5%) over three successive readings.

6. If sampling for dissolved metals, field filter sample according to SOP-04.

7. Label each sample container with project number, sample location, well owner, date, military time, sampler's initials, preservative, and analysis required. For inorganics samples, rinse sample containers, without preservatives, three times with sample water before final collection. Do not rinse containers for organics analysis.

8. Pour the sample into the appropriate sample containers and and any needed preservatives in

accordance with SOP-42. Also see ("Handbook for Sampling and Sample Preservation of Water and Wastewater", EPA-600/4-82-029; "Guidelines Establishing Test Procedures for the Analyses of Pollutants Under the Clean Water Act", 40 CFR 136; and "Test Methods for Evaluating Solid Wastes," EPA SW-846). A few common sample preservatives are listed below:

Dissolved Metals	Add 3-4 ml. Nitric Acid to 500 ml. sample
Nutrients	Refrigerate to 4°C; Add 3-4 ml. Sulfuric Acid to 500 ml.sample
Common Ions	Refrigerate to 4°C
Hydrocarbon VOA	Refrigerate to 4°C; Add 3-4 drops HCl*
Diesel Range Organics	Refrigerate to 4°C; Add 80 drops (4ml) HCl
Fluorescent Tracer Dye	Refrigerate to 4°C; Prevent exposure to light

For additional bottling and sample preservation information, consult the Maxim Technologies, Inc. laboratory.

9. For volatile analyses add preservative to sample vial and fill vials at the rate of 100 milliliters per minute (24 seconds for 40 milliliter vial); form positive meniscus over vial brim and cap. After capping, invert vial, gently tap and look for air bubbles. If bubbles are present, un-cap vial, add more water and repeat procedure.

10. If required by the project workplan, perform field parameter tests including pH, SC, Eh, and temperature on water sampled from the well. Record field measurements on field forms.

11. Complete the necessary shipping and handling paperwork, and record all pertinent information on Field Sampling Form in accordance with SOP-10.

STANDARD OPERATING PROCEDURE

FIELD MEASUREMENT OF GROUND WATER LEVEL

1. Calibrate well probe to a steel tape prior to and following each data gathering episode. Note any corrections to well probe measurements on field forms.

2. Check well probe prior to leaving for field for defects by placing probe in water and testing buzzer and light. Repair as necessary. Make certain the well probe, a tape measure calibrated to tenths of feet and extra batteries are in the carrying case.

3. Measure all wells (monitoring and domestic) from the top of the well casing in the north quadrant or from a designated measuring point, as appropriate. Measure and record distance from measuring point to ground level. Make sure measuring point is labeled on well, so future measurements can be made from the same location.

4. Obtain a depth to water from measuring point to the nearest hundredth of a foot. Record data on appropriate field forms.

5. Decontaminate well probe between each measurement by rinsing with deionized water. Additional decontamination, such as liquinox scrubbing, may be required for certain wells; consult the project work plan.

STANDARD OPERATING PROCEDURE

SOIL SAMPLE COLLECTION

This SOP describes the field equipment and sampling methods for surface and subsurface sampling of soil material. Methods explained in this SOP may be different from those identified in the project specific Sampling and Analysis Plan (SAP) and the project specific SAP should be referenced for additions or deletions to the methods noted below. All sampling equipment should be cleaned before arriving on site.

FIELD EQUIPMENT

- Sharp shooter and clean-out shovel
- Stainless steel mixing bowl and sampling trowel
- Dilute (10%) hydrochloric acid
- Hand lens (10) power
- Steel tape (10 foot)
- pH and electrical conductivity meters (if required)
- Munsel color book (if required)
- No. 10 sampling screen
- Field forms and field book
- Bucket augers

SURFACE SAMPLING

Surface soil/tailings samples are collected from the surface to a depth of one inch unless otherwise specified in the project specific SAP. Sufficient sample will be collected for the analysis that will be performed but generally this will be on the order of one gallon. Soil samples will be collected in either wide mouth glass jars or resealable polyethylene bags (ziploc or equivalent).

Samples should be described according to the procedures outlined in the Unified Soil Classification System (USCS; method ASTM D2487) or the Soil Conservation Service (SCS) classification system. Soil texture should be classified by either the USCS or U.S. Department of Agriculture (USDA) classification. Descriptions shall be recorded in field books or on standard morphological description logs as provided in the SAP.

Samples should be collected from an area of approximately six square feet by digging up the top inch with the sampling trowel and placed in the mixing bowl. The sample should be screened with the 10 mesh sieve if coarse fragments are to be excluded from the sample. If a sod or duff layer is present, this layer should be pealed back to the top of the mineral soil.

The sample placed in the mixing bowl shall be well mixed and then a portion of the sample placed in the sample container. To select a sample from the mixing bowl, quarter the sample in the bowl and place an equal volume of soil from each quarter in the sample container. When sampling soil for organics, the samples should not be mixed.

All equipment used in the sampling of surface soils will be decontaminated using the procedures in SOP-11. All necessary paperwork will be filled out in accordance with SOP-12.

SUBSURFACE SAMPLING

Subsurface sampling will be completed using a bucket auger, split spoon sampler, or hand dug or backhoe excavated pits. Sampling procedures for each type of equipment is described below. Sample collection, homogenation, and transfer to sampling containers should follow the same procedures as outlined for collection of surface samples.

Bucket Auger

1. Arrive on-site equipped with stainless steel auger rod and several sizes of stainless steel bucket augers (e.g. 2-inch, 4-inch, 6-inch, etc.).

2. Bucket auger holes can be drilled as one size or in a telescoping manner if contamination between sample intervals is a concern. If a single sized, advance the bucket auger to the desired sampling interval depth and empty the contents of the auger in a stainless steel mixing bowl. For the telescoping method, advance the largest auger to an approximate depth of three feet, collecting specified depth increment samples as the auger is advanced. Install temporary decontaminated PVC casing with a diameter slightly smaller than the borehole to keep the hole open and reduce possible cross-contamination between depth intervals. Using the next size smaller bucket auger, repeat the process.

3. Select sample intervals for packaging for laboratory analysis in accordance with procedures described in the SAP.

4. Fill out appropriate paper work and bottle labels as necessary prior to leaving site.

5. Decontaminate all equipment between sample locations.

Split Spoon Sampler

1. Arrive on-site equipped with at least two standard 1.4 inch inside diameter split spoon samplers. If geotechnical information is desired, a 140 pound drive hammer is required.

2. Install sampler into borehole and advance to the desired depth with the 140 pound drop hammer or equivalent means. Record number of blow counts to complete sampling over each 18-inch interval, as necessary. Retrieve sampler and place on work table. Using the other sampler, repeat this sequence.

3. Record lithology and percent recovery from cores retrieved from split spoon sampler.

4. Based upon the project work plan or sampling and analysis plan, composite like core intervals by mixing in stainless steel bowl in a similar manner as described for surface sampling. When sampling for organics, the sample should not be mixed.

5. Decontaminate sampling equipment between each interval sampled if required by the SAP. Decontaminate sampling equipment between sampling sites.

Backhoe or Hand Dug Excavations

1. Locate the site to be sampled and insure that equipment can safely access the site. Minimize off road travel to prevent off site damage to surrounding vegetation.

2. Orient excavation to maximize use of the angle of the sun to illuminate the pit for photographs. Place excavated material a sufficient distance from the excavation.

3. Excavate to the prescribed depth. If the pit exceeds five feet in depth, OSHA construction standards for shoring or sloping must be observed to prevent accidental burials. Sampling personnel should enter the pit with care during and after excavation.

4. Soil profile descriptions shall be made from a hand cleaned surface along the pit wall. Complete profile descriptions and take photographs before pit is sampled.

5. Soil samples shall be collected from depth intervals specified in the SAP. When a depth interval is sampled, an equal volume of soil should be collected from the entire interval exposed on the pit wall. Soil samples will be collected with the stainless steel trowel and mixing bowl according to methods described for surface soil sampling. When sampling for organics, the sample should not be mixed.

6. After sampling is completed, the pit should be backfilled with excavated material in the reverse order that it was excavated so that topsoil material is returned to the top of the pit. When backfilling is complete the area should be cleaned-up to its original condition.

7. Decontaminate sampling equipment between sampling sites. Excavation equipment should be cleaned between sites with water (where possible) or with a shovel to remove accumulated dirt and mud.

STANDARD OPERATING PROCEDURE

FIELD MEASUREMENT OF REDOX POTENTIAL (Eh)

1. Inspect the instrument and the probe to insure all parts, as listed in the owner's manual, are in the field case. It is very important that the Eh probe is in good condition, free of cracks, and that adequate solution is contained in the Eh electrode.

2. Calibrate the Eh instrument in accordance with manufacturer's recommendations daily or more frequently if conditions warrant.

3. Decontaminate a sample beaker in accordance with SOP-11.

4. Rinse Eh electrode with deionized water and then with sample water prior to inserting into sample beaker.

5. Obtain sample of water using a method which minimizes agitation of the sample. The more the sample is exposed to oxygen, the more likely it is that erroneous data will be obtained. If possible, obtain an in situ measurement of Eh.

6. If extractive methods are used to obtain water samples, fill the sample beaker with sample water which has been <u>recently</u> evacuated from well and, again, minimize agitation.

7. Immerse the Eh electrode in sample and allow several minutes for the probe to equilibrate with the water.

8. Obtain reading to nearest ten millivolts.

9. Record reading on standardized field forms or in the field book. Note any problems such as erratic or drifting readings.

10. Rinse probe with deionized water and store according to manufacturer's directions.

SOP-46

STANDARD OPERATING PROCEDURE
MACROINVERTEBRATE TISSUE
SAMPLING AND DATA COLLECTION

This Standard Operating Procedure (SOP) is intended to provide guidance and consistency in field sampling, sample preservation, and quality control/quality assurance for the sampling of benthic invertebrates for tissue analysis.

Aquatic Macroinvertebrate Tissue Sampling

Methodologies employed to collect sufficient macroinvertebrate biomass for tissue analysis are based on: United States Environmental Protection Agency (USEPA) *Rapid Bioassessment Protocol for Use in Streams* (Barbour et al. 1999) and Montana Department of Environmental Quality (MDEQ) Water Quality Planning Bureau's SOP, *Sample Collection, Sorting, and Taxonomic Identification of Benthic Macroinvertebrates* (MDEQ 2006).

Equipment

- Dip nets (D-Frame 500 µm mesh)
- Surber or Hess sampler (500 µm mesh)
- Sample jars (250mL glass or plastic wide-mouth bottles)
- Digital camera and batteries
- GPS unit
- Waders (hip)
- Watch
- Clipboard/data sheets
- Labels, markers and tape
- Sorting pan
- Digital scale
- Squirt bottles
- Forceps
- DI water
- Alconox
- 10% nitric acid solution
- Scrub brush
- Cooler
- Ice

Sample Collection

Sample sites will be selected as shown in the project Sampling and Analysis Plan. Generally, these will be shallow riffle sites with a velocity equal to or less than 1.5 feet per second. Dip netting is the preferred method for collection due to the ease of use and the greater degree of portability when compared to Surber or Hess samplers. A Modified Surber or Hess Sampler may be used as designed if field conditions allow.

Dip-Netting

Riffles will be sampled according to MDEQ procedures by employing the traveling kick net method. Pool tail-outs or shallow pools may also be sampled in order to meet the multi-habitat sampling approach defined in Technique 2 of Barbour et al (1999). When riffles are rare or non-existent, as in low-gradient streams, a dip-net “jab” sampling method is the preferred method for sampling.

In general, the dip netting technique uses a D-frame dip net (500 µm, or equivalent) to sample a reach of stream that is of at least one meander length or approximately 20 times the bankfull channel width. The approximate proportion of productive macroinvertebrate habitat will be sampled accordingly. Productive habitat types for macroinvertebrates include riffles, snags, aquatic vegetation, and bank margins.

Specifically, the traveling kick net method to be used in riffles is a vigorous shuffling of the sampler’s feet in the substrate while moving diagonally and upstream to dislodge macroinvertebrates from their habitat. The dip net is held vertically in continuous contact with the substrate directly downstream of the sampler. Excess debris and rocks should be removed from the dip net as it accumulates with care taken to rinse all macroinvertebrates from them prior to discarding them downstream of the current sampling path.

The “jab” sampling method is meant to sample approximately 1 meter of length with the net. “Jabs” will be proportionally allocated to the relative occurrence in the reach of habitat types. If the current is too slow to efficiently capture macroinvertebrates in a riffle using a traveling kick, then jab net along the riffle bottom in an upstream direction, attempting to dislodge and catch invertebrates without retaining excessive debris. Snag areas and aquatic vegetation are sampled using similar techniques. To sample snags and aquatic vegetation, sweep the dip net through and around the snag and aquatic vegetation for roughly a meter of stream length. The dip net should be swept in such a manner to dislodge and capture inhabiting macroinvertebrates. In the case of larger, courser snags, macroinvertebrates should be scrubbed off by hand into the net.

Modified Surber or Hess Sampler Methods

Specimens will be dislodged from the substrate by turning over all rocks and other material within the sampler’s frame, and allowing them to drift by current into the bag of the sampler. A minimum of three samples will be collected at each sampling location. The samples will be aggregated in the field for analysis. The Modified Surber or Hess Sampler should be held as close to the bottom of the stream as possible to provide capture of the maximum amount of dislodged specimens. This sampling technique should continue for approximately one minute.

Procedure for Preparing Samples for Benthic Macroinvertebrate Tissue Analysis

1. Pour the entire contents of the sample bucket into the sorting pan. Remove any large objects and wash off any clinging organisms back into the pan before discarding.

2. Using a wash bottle filled with stream water, rinse all the organisms from the bucket into the sorting pan. This is the source of the sample for the site.

3. Weigh the empty collection jar using the digital scale to establish the tare weight, and to establish the target weight of the collection jar and the macroinvertebrates to be submitted for analysis.

4. Fill in a sample label with the stream ID and date of collection. Attach the completed label to the jar and cover it with a strip of clear tape.

5. Sort through the sample and place macroinvertebrates into the collection jar approximately in an equal proportion to that which is found in the sample. Caddis flies (Trichopterans) should be removed from their casings prior to being placed in the collection jar.

6. Continue sorting though the sample until a target weight of at least five grams (0.176 ounces) of macroinvertebrate tissue sample is obtained. It may be necessary to return to the stream to get more

sample material if the target weight is not met with the first sample. A five gram tissue sample is needed to supply the analytical laboratory with sufficient sample to run the analyses required and any internal quality assurance/quality control that the laboratory may need to do. At times, due to time constraints and habitat limitations, it may be necessary to supply the laboratory with a sample that does not meet the five gram requirement. Sterile gloves should be worn during this step to reduce the potential for contamination.

7. Once the target weight is met, replace the lid of the collection jar, record the total weight, and place the jar into a chilled cooler as soon as practicable. Since these samples are not being submitted for taxonomic identification, preservation with alcohol is not necessary, and the use of alcohol may introduce unknown contaminants. Samples should be stored in a freezer upon return from the field and kept there until shipped.

8. Clean any materials that have, or may come into contact with future samples or sampling materials by first scrubbing with a detergent solution, such as alconox, then rinsing with distilled water. Ensure that any remaining debris is removed from the sampling materials and that the sampling materials are thoroughly cleaned. After the first rinse, used materials should be doused with a 10% nitric acid solution and then rinsed again. Gloves should be worn during this step as a safety procedure since nitric acid is being used.

Quality Assurance/Quality Control

The following measures will be taken to maintain consistency in sample collection:

When duplicate samples are collected at a site, the same sampler should collect these samples. This will minimize differences between duplicate samples by providing the same general "level of effort" by the sampler. Field data sheets and detailed field notes will include GPS location, description of the site(s) sampled, sketch or photograph of the site, sampler(s), and other relevant site-specific observations. Duplicate samples will be collected at a rate of one for every, or portion of, ten samples collected. For instance if 17 samples are collected, two duplicate samples will be collected. Blank samples will not be collected.

References

Barbour, M., J. Gerritsen, B. Snyder and J. Stribling. 1999. *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish*. Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency, Office of Water. Washington, D.C.

Montana Department of Environmental Quality (MDEQ). 2006. *Sample Collection, Sorting, and Taxonomic Identification of Benthic Macroinvertebrates.* Montana Department of Environmental Quality, Water Quality Planning Bureau, Standard Operating Procedure: WQPBWQM-009

SOP-47

STANDARD OPERATING PROCEDURE MACROINVERTEBRATE AND PERIPHYTON SAMPLING AND DATA COLLECTION

This Standard Operating Procedure (SOP) is intended to provide guidance and consistency in field sampling, sample preservation, and quality control/quality assurance for monitoring of benthic invertebrates.

Aquatic Macroinvertebrate and Periphyton Assemblage

Methodologies to be employed are based on: USEPA *Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters* described (Klemm et al. 1990); USEPA *Rapid Bioassessment Protocol for Use in Streams* (Barbour et al. 1999); and MDEQ Water Quality Planning Bureau's SOP, *Sample Collection, Sorting, and Taxonomic Identification of Benthic Macroinvertebrates* (MDEQ 2006).

Macroinvertebrate Sampling

Macroinvertebrate sampling, preservation of samples, and associated work will be performed in accordance with guidelines recommended in Winget and Mangum (1979). This will ensure that all measurements and ratings are consistently and appropriately obtained.

Equipment

- Physical characterization / water quality field data sheets
- Habitat Assessment Field Data Sheets and Site Visit Forms (Feldman et al. 2005; Copies are attached to this SOP)
- 280 micron Modified Surber Sampler or Hess Sampler (or);
- Dip nets (D-Frame 800/900 um Multifilament). 500 um is also adequate
- Sample jars (1 L plastic wide-mouth bottles) with waterproof adhesive labels
- Digital camera and batteries
- GPS unit
- Tape measure
- Waders (hip)
- Watch
- Clipboard/data sheets
- 95% Ethanol preservative
- labels, markers and tape
- funnel
- large bucket or pan
- DI water
- sieve net
- forceps

Sample Collection

Sample sites will be selected as shown in the project Sampling and Analysis Plan. Generally, these will be shallow riffle sites with a velocity equal to or less than 1.5 feet per second. Field forms are to be completed for each sample event including documentation of physical characteristics and habitat assessments recommended by Winget and Mangum (1979). The Modified Surber or Hess Sampler may be used as designed if field conditions allow. Dip netting may also be employed as the preferred method for collection.

Modified Surber or Hess Sampler Methods

Specimens will be dislodged from the substrate by turning over all rocks and other material within the sampler's frame, and allowing them to drift by current into the bag of the sampler. A minimum of three samples will be collected at each sampling location. The samples will be aggregated in the field for analysis. The Modified Surber or Hess Sampler should be held as close to the bottom of the stream as possible to provide capture of the maximum amount of dislodged specimens. This sampling technique should continue for approximately one minute.

Dip-Netting

When riffles are rare or non-existent, as in low-gradient streams, a dip-net "jab" sampling method is the preferred method for sampling. A single jab is meant to sample approximately 1 meter of length with the net; there should be 20 "jabs" per sample (Feldman et al. 2005). The Montana DEQ *Sample Collection, Sorting, and Taxonomic Identification of Benthic Macroinvertebrates SOP* for low-gradient streams will be employed. The Dip-netting method is described below in detail.

- A Wildco D-Frame Dip Net with 800 x 900 mm multifilament nylon or equivalent will be employed for collecting macroinvertebrates.
- Sampling reaches will be of at least 1 meander length, or better, about 20 bankfull channel widths.
- The approximate proportion of productive macroinvertebrate habitat will be recorded. Productive habitat types are: riffles, snags, aquatic vegetation, and bank margins.
- Jabs will be proportionally allocated to the relative occurrence in the reach of habitat types.
- 20 jab samples will be collected by moving in an upstream direction through the reach, proportionally allocating jabs among habitat types as determined above.
- Specific jab methods for typical productive habitats are as follows:

<u>Riffles</u>**:** travel 1 meter for each jab allocated for riffle habitat. If the current is too slow to efficiently capture macroinvertebrates in the riffle using a traveling kick, then jab net along the riffle bottom in an upstream direction, attempting to dislodge and catch invertebrates without retaining excessive debris.

<u>Snags</u>**:** Sample roughly an equivalent of a meter sweep through and around the snag in such a way as to dislodge and capture inhabitants. Macroinvertebrates should be scrubbed off by hand into the net on coarser snags.

<u>Aquatic vegetation</u>**:** Sweep the net through the vegetation for about 1 meter trying to loosen and capture macroinvertebrates.

<u>Bank margins</u>**:** Typically a modification/combination of jabs is recommended for the above habitats, depending on the nature of the habitat at the site.

PROCEDURE FOR PREPARING SAMPLES FOR BENTHIC MACROINVERTEBRATES

1) Pour the entire contents of the “sample” bucket through a sieve with 500 µm mesh size. Remove any large objects and wash off any clinging organisms back into the sieve before discarding.

2) Using a wash bottle filled with stream water, rinse all the organisms from the bucket into the sieve. This is the sample for the site.

3) Fill in a sample label with the stream ID and date of collection. Attach the completed label to the jar and cover it with a strip of clear tape.

4) Wash the contents of the sieve to one side by gently agitating the sieve in the water. Wash the sample into a jar using as little water from the wash bottle as possible. Use a large-bore funnel if necessary. If the jar is too full pour off some water through the sieve until the jar is not more than ¼ full, or use a second jar if a larger one is not available. Carefully examine the sieve for any remaining organisms and use watchmakers’ forceps to place them into the sample jar. If a second jar is needed, fill in a sample label that does not have a pre-printed ID number on it. Record the ID number from the pre-printed label prepared in Step 3 in the “SAMPLE ID” field of the label. Attach the label to the second jar and cover it with a strip of clear tape.

5) Place a waterproof label (filled out in PENCIL) with the following information inside each jar:

   - Sample ID number
   - Date of collection
   - Type of sampler and mesh size used
   - Collectors initials
   - Habitat type (riffle or pool)
   - Number of transect samples
   - Name of stream composited

6) Completely fill the jar with 95% ethanol (no headspace) so that the final concentration of ethanol is between 75 and 90%. It is very important that sufficient ethanol be used, or the organisms will not be properly preserved. NOTE: Prepared composite samples can be transported back to the vehicle before adding ethanol if necessary.

7) Replace the cap on each jar. Slowly tip the jar to a horizontal position, then gently rotate the jar to mix the preservative. Do not invert or shake the jar. After mixing, seal each jar with plastic tape.

8) Store labeled composite samples in a container with absorbent material that is suitable for use with 95% ethanol until transport or shipment to the laboratory.

Periphyton Sample Collection

Periphyton sampling, preservation of samples, and associated work will be performed in accordance with guidelines recommended in the USEPA *Field Operations Manual for Wadable Streams* (Peck 2002). This will ensure that all measurements and ratings are consistently and appropriately obtained.

Additional Equipment

- 2 Large funnels (15 – 20 cm in diameter)
- 2 Stiff bristle toothbrushes (or equivalent)
- 2, 12-cm^2 area delimiters (3.8 cm pipe, 3 or 4 cm tall)
- 2, 1-L wash bottles for stream water

- 2, 1-L wash bottle labeled for and containing deionized water
- 3, 500-mL plastic bottles (tinted with volume markings) for composite samples, labeled “PERIPHYTON COMPOSITE SAMPLE”
- 2, 35-60 mL catheter-tipped plastic syringes
- 10% formalin solution for ID/Enumeration samples
- Several (a dozen or more) small syringe or bulb pipette for dispensing formalin
- Chemical-resistant gloves for handling formalin
- Safety glasses for use when handling formalin

PROCEDURE FOR PREPARING COMPOSITE SAMPLES FOR PERIPHYTON

Erosional habitats:

1) Collect a sample of substrate (rock or wood) that is small enough (< 15 cm diameter) and can be easily removed from the stream. Place the substrate in a plastic funnel, which drains into a 500-mL plastic bottle with volume graduations marked on it and labeled "PERIPHYTON."

2) Use the area delimiter to define a 12-cm^2 area on the upper surface of the substrate. Dislodge attached periphyton from the substrate within the delimiter into the funnel by brushing with a stiff-bristled toothbrush for 30 seconds. Take care to ensure that the upper surface of the substrate is the surface that is being scrubbed, and that the entire surface within the delimiter is scrubbed.

3) Fill a wash bottle with stream water. Using a minimal volume of water from this bottle, wash the dislodged periphyton from the rock, delimiter, and funnel into the 500-mL bottle.

Depositional habitats:

1) Use the area delimiter to confine a 12-cm^2 area of soft sediments.

2) Vacuum the top 1 cm of sediments from within the delimited area into a 60-mL syringe.

3) Empty the syringe into the 500-mL “PERIPHYTON” bottle (combining it with samples collected from erosional habitats).

4) Each reach will have its own composite sample. Keep the collection bottles out of direct sunlight as much as possible to minimize degradation of chlorophyll. Bottles should be tinted plastic.

5) After samples have been collected from all three sample sites per reach, mix the 500-mL bottle thoroughly. Record the total estimated volume of the composite sample. Record the number of stations at which you obtained a periphyton sample. In this case it will be three.

Quality Assurance/Quality Control

The following measures will be taken to maintain consistency in sample collection:

When replicate samples are collected at a site, the same sampler should collect these samples. This will minimize differences between replicate samples by providing the same general "level of effort" by the sampler. Field data sheets and detailed field notes will include GPS location, description of the site(s) sampled, sketch or photograph of the site, sampler(s), and other relevant site-specific observations

References

Barbour, M., J. Gerritsen, B. Snyder and J. Stribling. 1999. *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish*. Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency, Office of Water. Washington, D.C.

Klemm, D.J., P.A. Lewis, F. Fulk, and J.M. Lazorchak. 1990. *Macroinvertebrate Field and Laboratory Methods for evaluating the Biological Integrity of Surface Waters.* EPA/600/4-90/030. U.S. Environmental Protection Agency.

Montana Department of Environmental Quality (MDEQ). 2006. *Sample Collection, Sorting, and Taxonomic Identification of Benthic Macroinvertebrates.* Montana Department of Environmental Quality, Water Quality Planning Bureau, Standard Operating Procedure: WQPBWQM-009.

Peck, D.V., J.M. Lazorchak, and D.J. Klemm (editors). **2002**. Unpublished draft. *Environmental Monitoring and Assessment Program -Surface Waters: Western Pilot Study Field Operations Manual for Wadeable Streams.* EPA/XXX/X-XX/XXXX. U.S. Environmental Protection Agency, Washington, D.C.

Winget, R. and F. Mangum. 1979. *Biotic Condition Index: Integrated Biological,Physical, and Chemical Stream Parameters for Management*. U.S. Department of Agriculture, Forest Service. Intermountain Region. Ogden, Utah.

STANDARD OPERATING PROCEDURE

DECONTAMINATION PROCEDURE FOR REDIFLOW SUBMERSIBLE PUMP

This SOP describes decontamination procedures for the Grundfos Rediflo® submersible pump or its equivalent. Field personnel must wear disposable latex or vinyl gloves while decontaminating equipment at the project site. Change gloves between every sample location. Every precaution must be taken by personnel to prevent contaminating themselves with the wash water and rinse water used in the decontamination process.

Table A-1 lists equipment and liquids necessary to decontaminate field equipment.

The following should be done in order to complete thorough decontamination of the submersible pump:

1. Set up the decontamination zone upwind from the sampling area to reduce the chances of windborne contamination.

2. Visually inspect sampling equipment for contamination; use stiff brush to remove visible material.

3. Wash the exterior of the pump and hose with a high pressure hot water wash using potable water from a known source.

4. Spray the exterior of the pump with a Liquinox® and deionized or distilled water solution.

5. Pump a Liquinox® and distilled or deionized water solution through the interior of the pump and hose from a decontaminated 5-gallon bucket.

6. As a final rinse, spray distilled or deionized water over the exterior of the pump and hose and pump deionized water through the interior of the pump and hose from a decontaminated 5-gallon bucket.

All disposable items (e.g., paper towels, latex gloves) should be deposited into a garbage bag and disposed of in a proper manner.

<u>TABLE A-1 EQUIPMENT LIST FOR DECONTAMINATION OF SUBMERSIBLE PUMP</u>

5-gallon plastic bucket	Liquinox® (soap)
Hard bristle brushes	5-gallon carboy of deionized water
Garbage bags	Latex or vinyl gloves
Spray bottles	Decontamination Trailer (steam-cleaner)

in: Rantz et al, 1982. Measurement and Computation of Streamflow: Volume 1 - Measurement of Stage and Discharge, Volume 2 - Computation of Discharge. U. S. Geological Survey Water-Supply Paper 2175.

APPENDIX A-3
FIELD FORMS

Surface Water Sampling Form

Groundwater Monitoring Well Lithologic and Completion Form

Groundwater Sampling Form

Test Pit Log

Chain-of-Custody Form

ENERGY LABORATORIES

Chain of Custody and Analytical Request Record

Page ____ of ____

PLEASE PRINT, provide as much information as possible. Refer to corresponding notes on reverse side.

Company Name:	Project Name, PWS #, Permit #, Etc.:
Report Mail Address:	Contact Name, Phone, Fax, E-mail: Sampler Name if other than Contact:
Invoice Address:	Invoice Contact & Phone #: Purchase Order #: ELI Quote #:

Report Required For: POTW/WWTP ☐ DW ☐ Other ____________

Special Report Formats - ELI must be notified prior to sample submittal for the following:

NELAC ☐ A2LA ☐ Level IV ☐

Other ____________

EDD/EDT ☐ Format ____________

Number of Containers / Sample Type: A W S V B O / Air Water Soils/Solids Vegetation Bioassay Other

ANALYSIS REQUESTED

SEE ATTACHED

Notify ELI prior to RUSH sample submittal for additional charges and scheduling

SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX										SEE ATTACHED	Normal Turnaround (TAT)	RUSH Turnaround (TAT)	Comments:	Shipped by: / Cooler ID(s) / Receipt Temp ____ °C / Custody Seal Y N / Intact Y N / Signature Match Y N / Lab ID
1																	LABORATORY USE ONLY
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

Custody Record MUST be Signed						
	Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
	Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
	Sample Disposal: Return to client: ______	Lab Disposal: ______		Sample Type: ______	LABORATORY USE ONLY # of fractions ______	

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.

Visit our web site at *www.energylab.com* for additional information, downloadable fee schedule, forms, & links.

Macroinvertebrate Field Form

Project Name ______________________ Project # ______________ Observers ____________

Date ____/____/____ GPS Receiver Type __________________ Sampler Used ______________

Stream Name	Site ID	Time	Air Temp	H_2O Temp	Elevation	UTM		Waypoint	Comments
		: am pm	°C °F	°C °F	m ft	N	E		
		: am pm	°C °F	°C °F	m ft	N	E		
		: am pm	°C °F	°C °F	m ft	N	E		
		: am pm	°C °F	°C °F	m ft	N	E		
		: am pm	°C °F	°C °F	m ft	N	E		
		: am pm	°C °F	°C °F	m ft	N	E		
		: am pm	°C °F	°C °F	m ft	N	E		
		: am pm	°C °F	°C °F	m ft	N	E		
		: am pm	°C °F	°C °F	m ft	N	E		
		: am pm	°C °F	°C °F	m ft	N	E		
		: am pm	°C °F	°C °F	m ft	N	E		
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		: am pm	°C °F	°C °F	m ft	N	E		
		: am pm	°C °F	°C °F	m ft	N	E		
		: am pm	°C °F	°C °F	m ft	N	E		

STREAM NAME ____________ REPLICATE # ____ DATE___/___/___ COMMENTS____________	STREAM NAME ____________ REPLICATE # ____ DATE___/___/___ COMMENTS____________	STREAM NAME ____________ REPLICATE # ____ DATE___/___/___ COMMENTS____________
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TETRA TECH, INC.

MONITORING WELL LITHOLOGIC AND COMPLETION LOG

JOB NO: ____________ WELL NO: ____________

PROJECT: ____________ STATE: MT COUNTY: ____________ LOGGED BY: ____________

LEGAL LOCATION:
T R S TRACT

DESCRIPTIVE LOCATION: ____________

DATE STARTED: ____________ DATE COMPLETED: ____________ DRILLING CO. & DRILLER: ____________

DRILLING METHOD ____________ BOREHOLE DIAM (IN): ____________ DRILL FLUIDS USED: ____________

TOTAL DEPTH DRILLED: ____________ TOTAL DEPTH CASED: ____________ INTERVAL PERFORATED FROM OR SCREENED (FT:) ____________ DIAMETER: ____________ CASING TYPE: ____________

METHOD OF PERFORATION:
____ Open Hole
____ Open Bottom
____ Saw Slotted
____ Factory ___ (size)
____ Other____

DURING WELL CONSTRUCTION WAS/WERE:

	YES	NO
Well Developed		
Well Pumped		
Water Samples Collected		
Material Samples Collected		

ANNULAR COMPLETION CHARACTERISTICS

WELL PROTECTOR: LENGTH: ____________ DIAM: ____________

LOCK NO: ____________

SURFACE SEAL TYPE: ____________ FROM: TO:
BACKFILL MATERIAL: ____________ FROM: TO:
FILTER PACK TYPE: ____________ FROM: TO:

STATIC WATER LEVEL: ____________ DATE: ____________

MEASURING POINT DESCRIPTION/ ELEVATION: ____________

MEASURING POINT RELATIVE TO GROUND SURFACE (+/-) ____________

REMARKS: ____________

INTERVAL(FT) below ground surface	LITHOLOGIC DESCRIPTION

MONITORING WELL LITHOLOGIC AND COMPLETION LOG (Cont'd)

JOB NO: ____________

PROJECT: ____________

WELL NO: ____________

INTERVAL(FT) below ground surface	LITHOLOGIC DESCRIPTION